THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXXV. No. 1930.] LONDON, MAY 8, 1900. [52ND YEAR. PRICE 6d.

TROTTER, HAINES, & CORBETT,
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FIRE-CLAY & BRICK WORKS,
STOURBRIDGE.

Manufacturers of GAS-RETORTS, GLASSHOUSE FURNACE & BLAST-FURNACE BRICKS, LUMPS, TILES, and every description of FIRE-BRICKS.
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SHIPMENTS PROMPTLY AND CAREFULLY EXECUTED.

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Yield of Gas per Ton .	10,500 Cubic Feet.
Illuminating Power . . .	16·4 Candles.
Coke	68 per Cent.

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W. RICHARDSON, Fitter.

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THE ORIGINAL
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Sent out in Dry Powder with Oils for mixing separate.
Is the most Durable Paint for all
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A PAINT MIXED READY FOR USE,
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MANUFACTURERS OF
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BRASS GAS-FITTINGS, GAS-VALVES, STEAM & WATER VALVES, TOOLS, &c., AND OF
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BIGGS, WALL, & CO.,
GAS AND WATER ENGINEERS,
13, CROSS STREET, FINSBURY PAVEMENT,
LONDON, E.C.

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FULL-WAY MAIN TAPS & LANTERN TAPS.
SEVERAL DESIGNS SHOWN BELOW.

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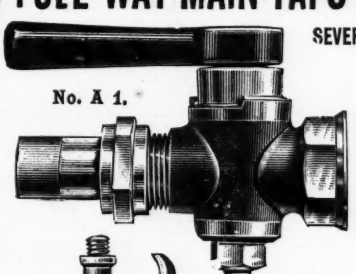

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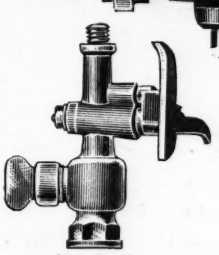
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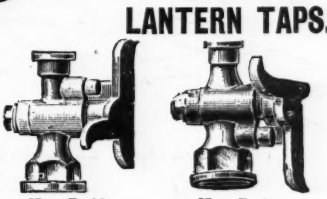
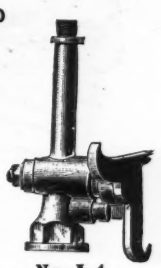

No. A 13. No. A 12.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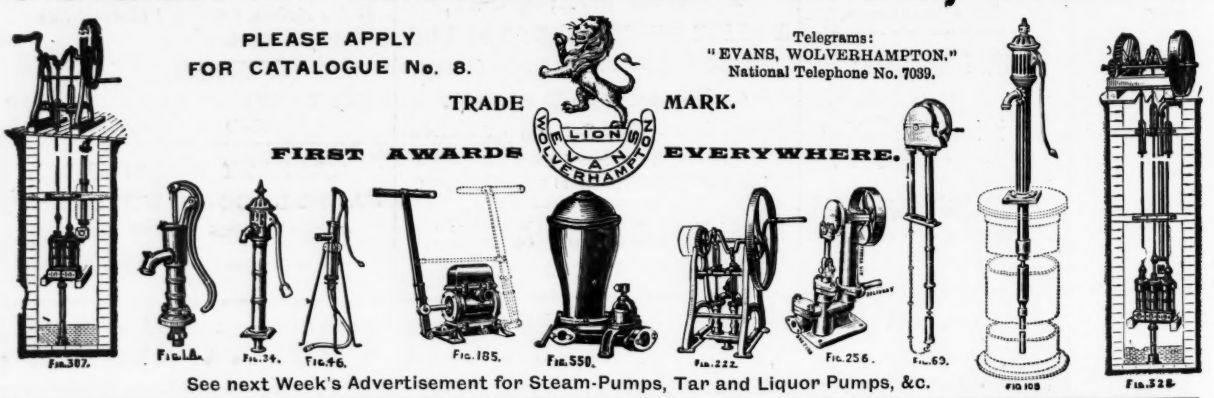

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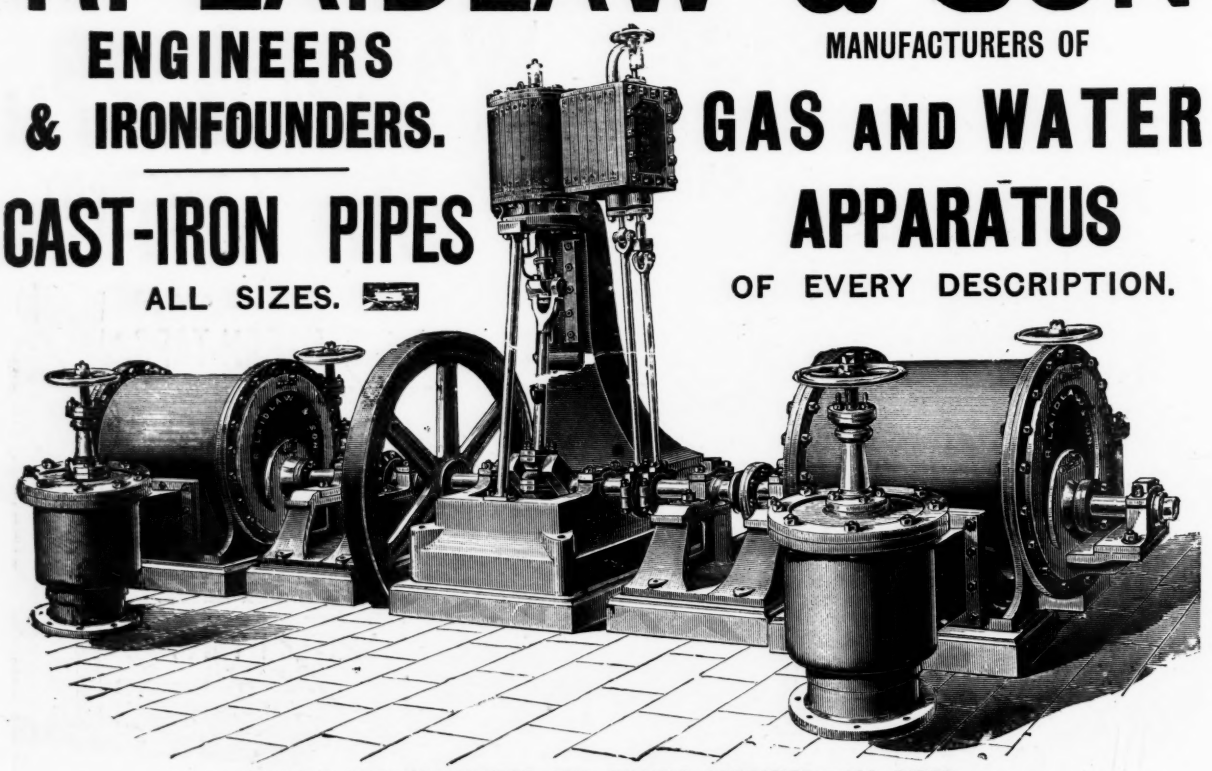

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ROOFING OF EVERY STYLE.

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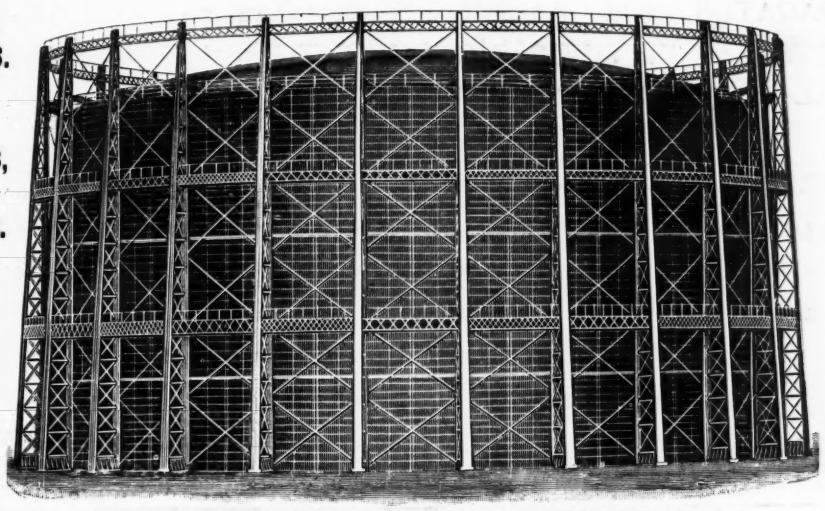

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ENGINES, EXHAUSTERS, STEAM BOILERS AND FITTINGS.

THREE-LIFT GASHOLDER. Capacity, SIX MILLION cubic feet.
240 feet Diameter by 45 feet Deep each Lift. Erected at Glasgow, 1893.

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ATLAS METER WORKS, OLDHAM.

Manufacturers of

ORME'S PATENT IMPROVED COIN METER.

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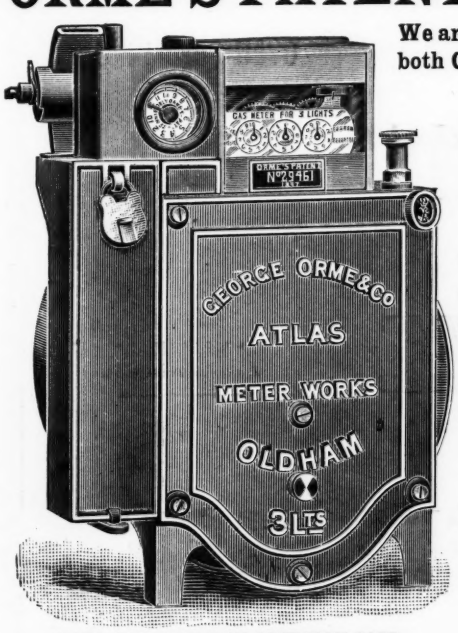


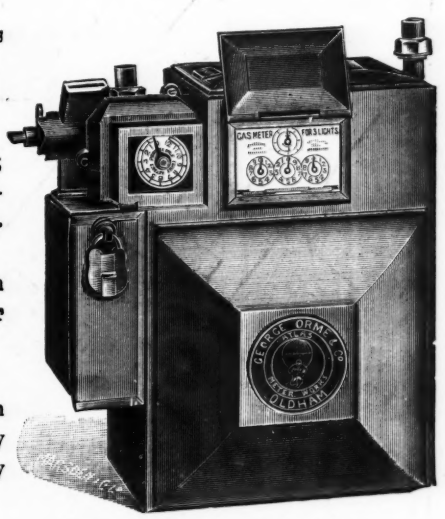
WET COIN METER IN CAST-IRON CASE.

A large number of these Meters are in use, and giving satisfaction.

The Mechanism is very simple; and there are no springs or complicated parts to get out of order.

We supply them to work with **1d., 1s., or any other Coin desired.**

The Selling Price of Gas can be changed *in Situ*, and any number of feet delivered, as may be required.



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Any further Particulars sent upon application.

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RETORTS and FITTINGS, MOUTHPIECES with Self-Sealing Lids.

Improved COAL and COKE HANDLING PLANT, CONVEYORS, and ELEVATORS,

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PURIFIERS with Planed Joints a Speciality.

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PIG IRON (Special Quality) for Engine Cylinders. GAS COAL famous for its UNRIVALLED EXCELLENCE.

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Built to any Specification or Gauge.

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FURNACE.

As used at BECKTON, BASINGSTOKE, CROYDON, DARTFORD, EASTBOURNE, HARROW, MAIDENHEAD, N. MIDDLESEX, RAMSGATE, SOUTH METROPOLITAN, WEST HAM, WATFORD, &c., &c.

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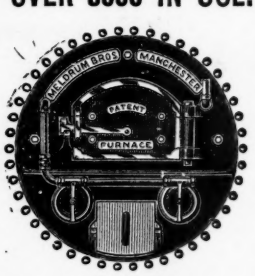

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PRICE'S COKE & COAL BARROW

effects a great saving of time, labour, and expense.

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Prices are Reduced.

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Manufacture and keep in Stock at their Works (also large stock in London)

PIPES and CONNECTIONS, 1½ to 48 inches in diameter, and make and erect to order RETORTS, PURIFIERS and TANKS, with or without planed joints, COLUMNS, GIRDERS, SPECIAL CASTINGS, &c., required by Gas, Water, Railway, Telegraph, Chemical, Colliery, and other Companies.

NOTE.—Makers of HORSLEY'S PATENT SYPHONS. These are cast in one piece, without Chaplets; doing away with Bolts, Nuts and Covers, and rendering Leakage impossible.

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MANUFACTURERS OF

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FOR ENGINEERS.

STEEL OF ALL DESCRIPTIONS.

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FOR

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For use in the

RECOVERY OF SULPHUR,

ALSO

Removal of last Traces of SULPHURETTED HYDROGEN in catch position.

Full Particulars on application to the Patentees:

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FABRIK CHEMISCHER PRAEPARATE VON STHAMER, NOACK, AND CO., HAMBURG.

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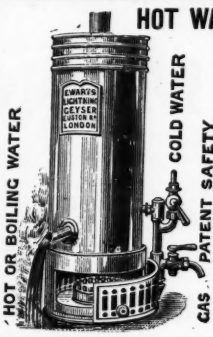

Hot Bath when wanted.

Boiling Water in a Minute.

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346, EUSTON ROAD, LONDON.

Illustrated Price List Free.

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Available Output up to 5000 Tons per day.

Yield of Gas 11,000 cubic feet per Ton of Coal as per Analysis by

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Yield of Gas per ton	13,155 cub. ft.
Illuminating Power	38·22 candles.
Coke per ton	1,301·88 lbs.

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Coke	70 per cent.

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Yield of Gas per ton	10,500 cub. ft.
Illuminating Power	16·3 candles.
Coke	73·1 per cent.

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LIME AND COLOUR WASHER.

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GREAT SAVING IN TIME, PAINT, AND LABOUR.

Painting Speed—3 Square Yards a Minute. Lime-Wash Speed—12 Square Yards a Minute.

Paint Machine, attached to a Single Air-Compressor, Driven by Belt Power. Can also be driven from existing Air-Mains.

No. 1	Painter	£25	Single Air	£17	10
No. 2	,,	£30	Compressor		
No. 3	,,	£35	Double ditto	£27	0

OVER 300 SOLD.

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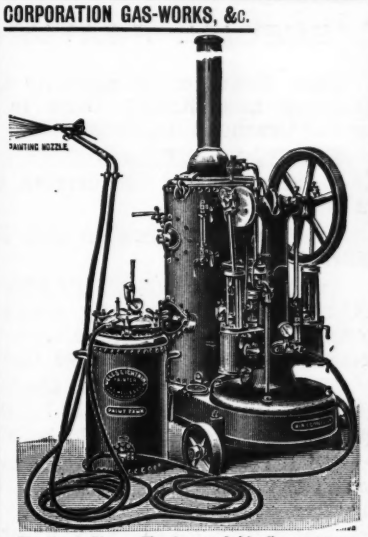

Vertical Steam-Engine and Air-Compressor combined with Boiler on Wheel Base.

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Larger size Engine, &c., adapted for working up to 4 Machines . . . £180.

Painting Machines Extra.

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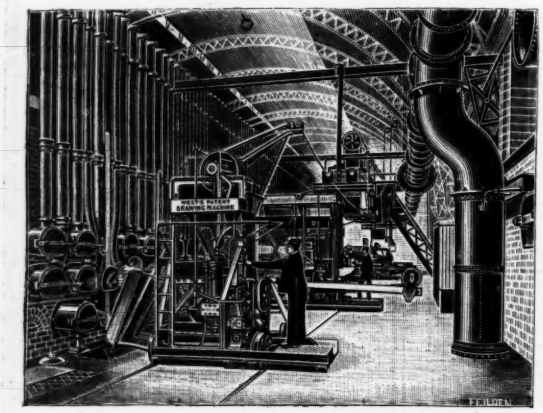
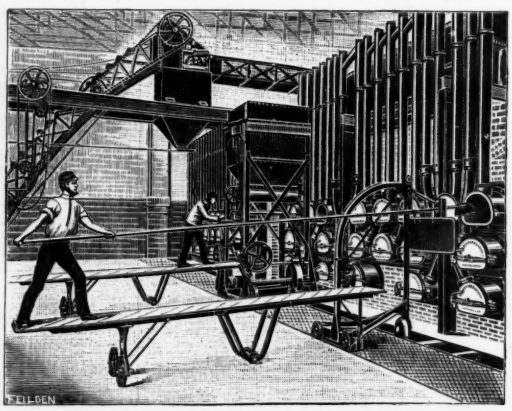
And 104, QUEEN VICTORIA STREET, LONDON, E.C.

MANCHESTER.



West's Compressed Air Charging and Drawing Machinery for Gas-Retorts.



West's Manual Charging and Drawing Machinery for Gas-Retorts.

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Silent Coke-Conveyor.

SPECIAL FEATURES:

This Conveyor is specially adapted for Elevating and Storing Coke in the Coke Yard or Overhead Hoppers.

SILENT IN ACTION, and is easily driven; the power required for driving being very small.

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No Rivets or Bolts in the Chain to work loose; the whole of the Chain being kept together by the Joint Pins.

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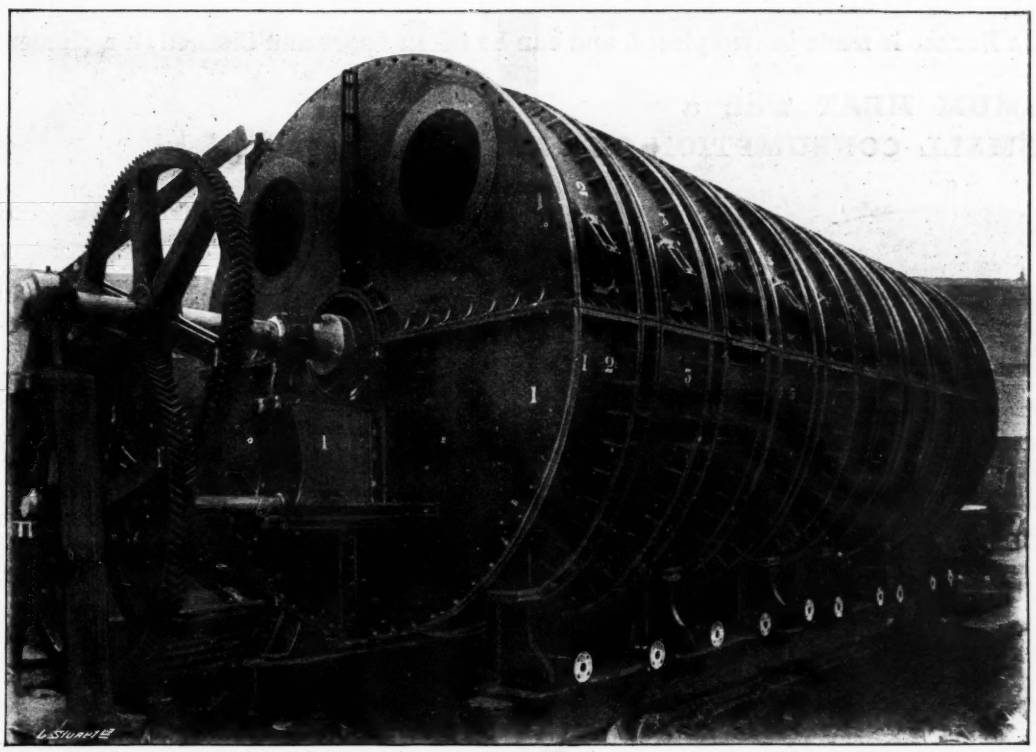
PATENT "NEW" SCRUBBER-WASHER

RESULTS GUARANTEED.



RESULTS GUARANTEED.

Similar Machine in course of construction for

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Bringing up the Output of Machines in under Four Years to over

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Having a capacity for treating 150,800,000 Cubic Feet of Gas per Diem.

ADVANTAGES.

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Practically the ENTIRE REMOVAL OF AMMONIA.

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Production of the HIGHEST STRENGTH of AMMONIACAL LIQUOR without any DETRIMENTAL EFFECTS upon the ILLUMINATING PROPERTIES of the GAS.

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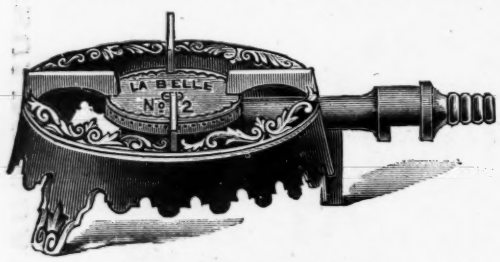
"LA BELLE" GAS-STOVES

Are MORE ECONOMICAL and CHEAPER than any OTHER STOVES of an EQUAL CAPACITY.

The Burner is made in two pieces, and can be taken apart and Cleaned in a Moment.

MAXIMUM HEAT with a SMALL CONSUMPTION OF GAS.



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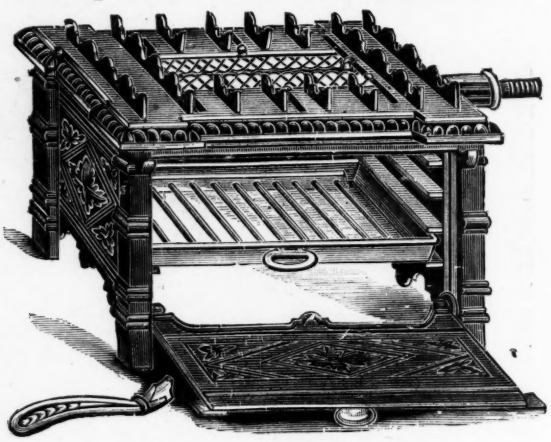

Stocked in Plain Black Iron, or with White Enamelled Interior.

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VERITAS LAMP WORKS,

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MAXIM PATENT CARBURETTOR

FOR ENRICHING GAS IN BULK.

OVER 70 MAXIM PATENT CARBURETTORS HAVE NOW BEEN FIXED.

Among the Companies supplied are The Gas Light and Coke Company, The South Metropolitan Gas Company, Birmingham Corporation, Manchester Corporation, Rochdale Corporation, Bristol Gas Company, and many other Works, both large and small, where they have been working in some instances for the past **Seven Years.**

MORE GAS & SALEABLE COKE PER TON of COAL CARBONIZED is PRODUCED; SAVING CAPITAL, LABOUR, FUEL, WEAR & TEAR, &c.

THE ENRICHMENT IS INSTANTANEOUS AND PERMANENT.

The Carburettor is inexpensive, easily fixed, and entirely supersedes the use of Cannel.

SOLE AGENTS FOR REDWOOD & CLOWES' INFLAMMABLE VAPOUR & GAS DETECTORS.

Dealers in Benzol, Carburine, and all other Naphthas and Oils suitable for the Enrichment of Gas.

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THE "DE BROUWER" PATENT COKE-CONVEYOR

FOR ELEVATING AND CONVEYING.

SUPERSEDES ALL OTHERS FOR DEALING AUTOMATICALLY WITH

— HOT COKE. —

DOES NOT BREAK THE COKE. SIMPLE AND EFFECTIVE.

25 INSTALLATIONS now at Work.

SUITABLE FOR SMALL AS WELL AS LARGE RETORT-HOUSES.

GUARANTEED BY SOLE MAKERS:

W. J. JENKINS & CO., Ltd., RETFORD.

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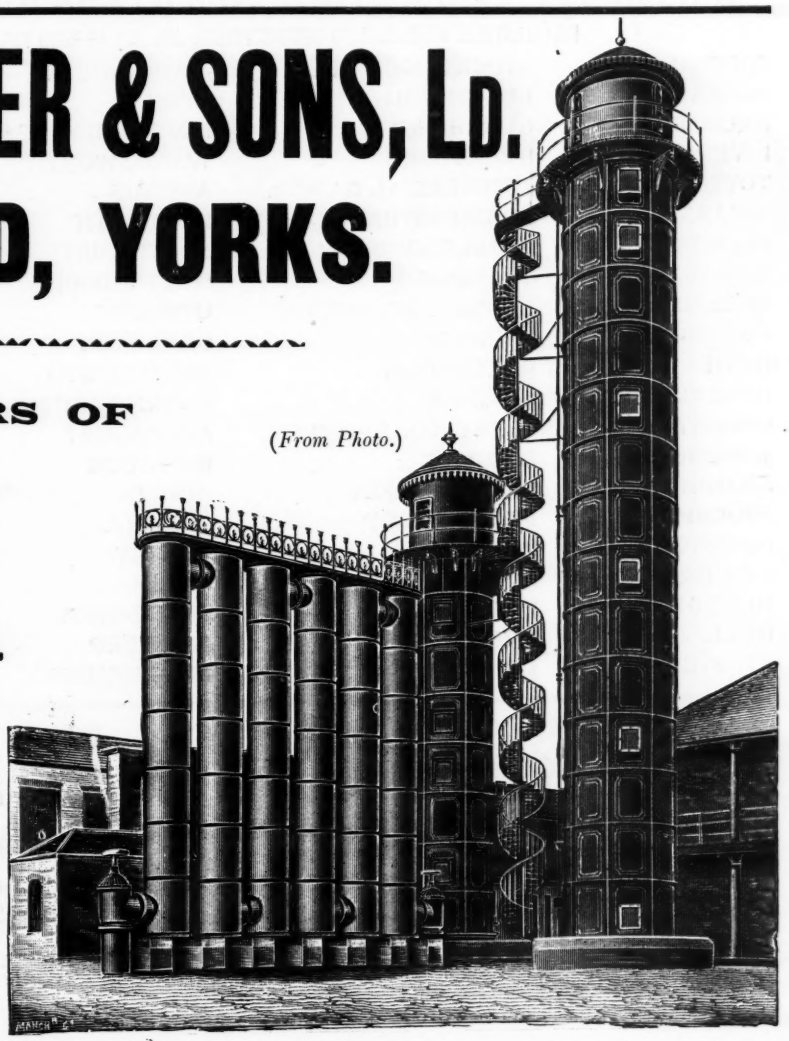
MANUFACTURERS OF

GAS PLANT

OF EVERY DESCRIPTION.

(*From Photo.*)



View illustrating Condensing and Scrubbing Plant erected for the Accrington Gas and Water Board by R. D. & Sons, Ltd.

C. HARRISON, Esq., Engineer.

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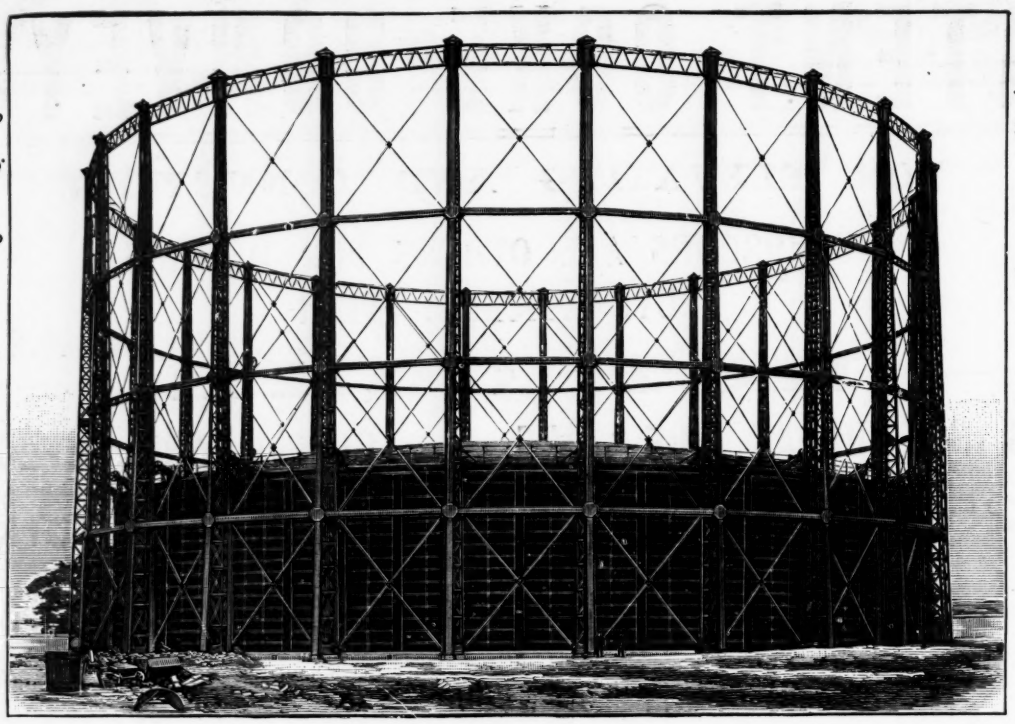

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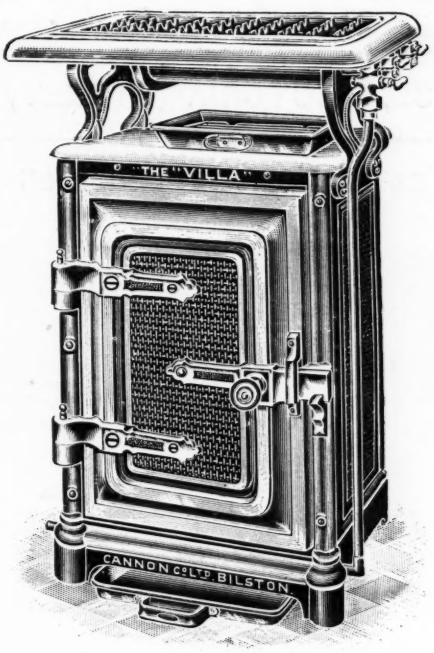

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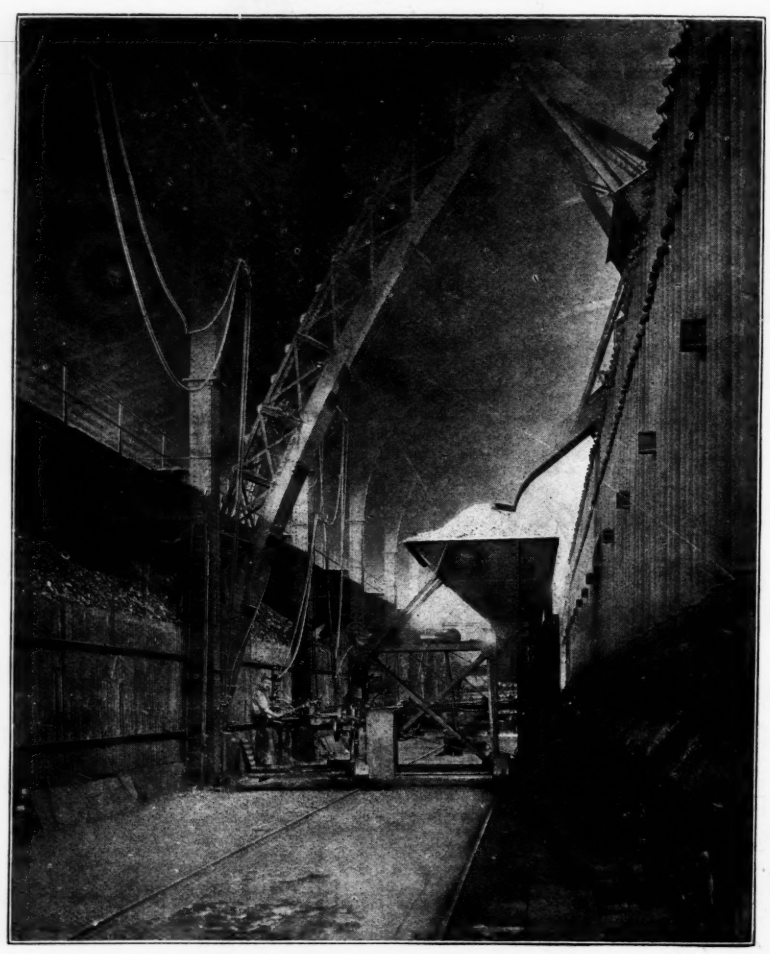

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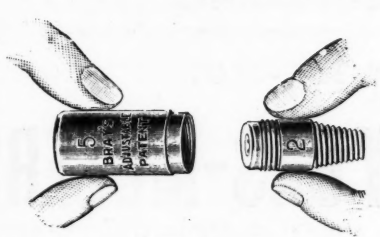

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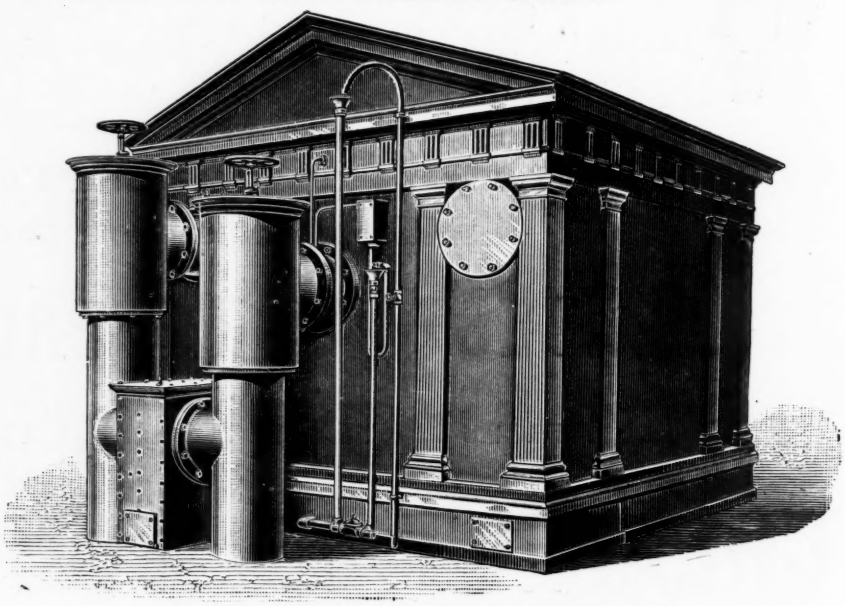

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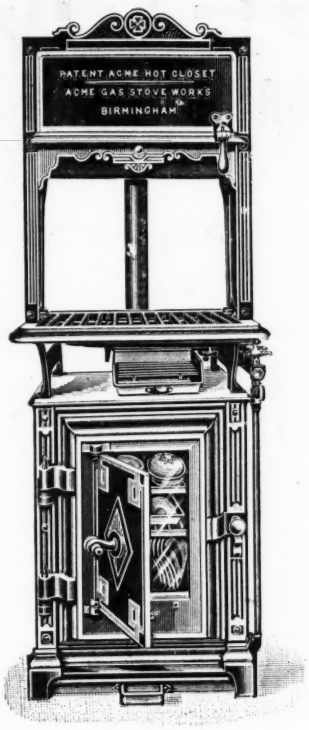

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DESIGNS AND ESTIMATES ON APPLICATION.

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PATENT "STANDARD" WASHER-SCRUBBER.

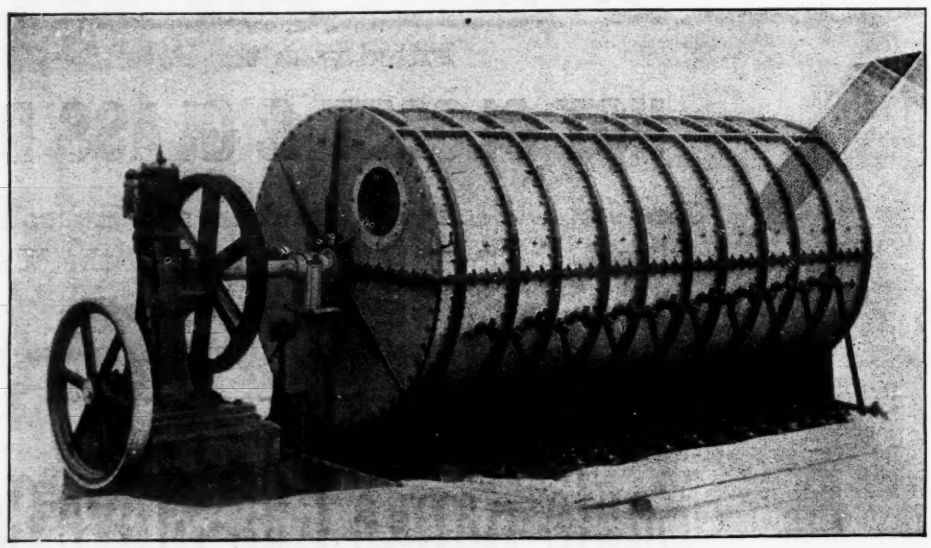

Photo. of one of two Patent "Standard" Washer-Scrubbers recently erected at Birmingham.

EXTRACTS **ALL** THE AMMONIA AND LARGE PROPORTION OF CO_2 AND H_2S.

NOTE: Particular attention is drawn to the fact that these Machines extract **ALL** the Ammonia, and that the strength of Liquor obtained depends on the class of Coal Carbonized and quantity of Water used.

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7 Patent "**STANDARD**" **WASHER-SCRUBBERS** in use in Bradford.
6 Patent "**STANDARD**" **WASHER-SCRUBBERS** in use in Leeds.
6 Patent "**STANDARD**" **WASHER-SCRUBBERS** in use in Nottingham.
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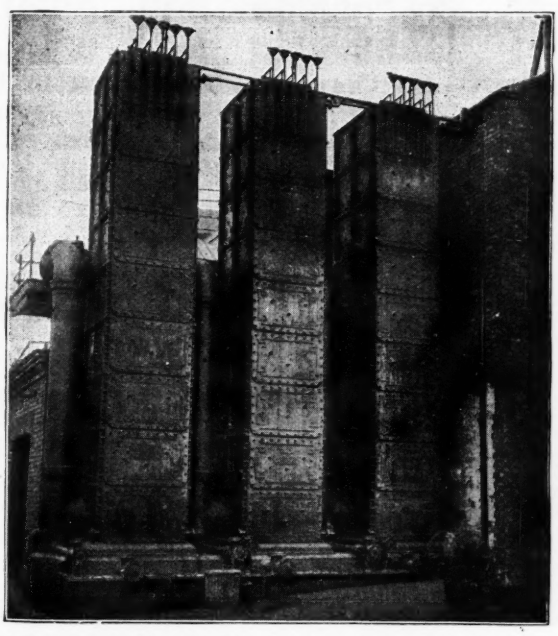

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3 Patent "**STANDARD**" **CONDENSERS**, Coventry.
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2 Patent "**STANDARD**" **CONDENSERS**, Scarborough.
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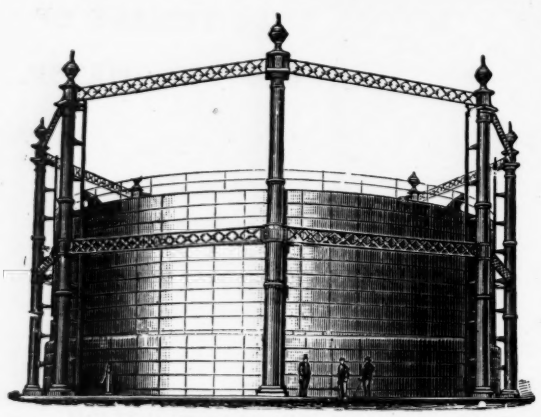

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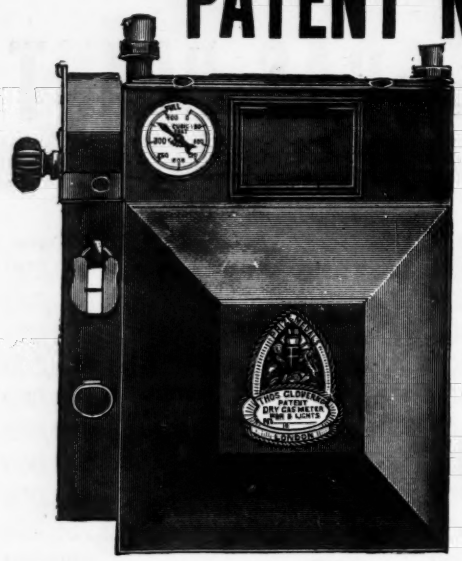

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TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion must be authenticated by the name and address of the writer; not necessarily for publication, but as a proof of good faith.

EDITORIAL NOTES.

The Meeting of the Institution of Gas Engineers.

THE meeting of the Institution of Gas Engineers last week, under the presidency of Mr. J. W. Helps, of Croydon, was of average interest, so far as the programme of business went; but the attendance suffered from the untoward clashing of the meeting with the continuation of the sittings of the Committees on the two biggest gas schemes of the year. The major interest for the gas engineering profession lay in the rooms where the future of the Gas Companies of London and of the suburbs of Bradford was being decided; and, as a consequence, the Institution came off second in their regard. This was a great pity; for the President and the Council of the Institution deserved a better fate. Both for his Inaugural Address and his conduct of the business of the meeting—including the delicate task of bringing before the members the scheme for their own translation into another "company"—Mr. Helps well earned the thanks of his colleagues; and it must have been a disappointment to him in particular to miss so many of those upon whom his predecessors in office had been able to rely for imparting vivacity and weight to the technical discussions of the Institution meetings. However, all those who could attend did so, if only for brief periods; and everybody loyally supported the chair to the best of his ability and opportunities. We deal at considerable length with the President's address elsewhere; suffice it therefore to remark here that it was of a quality to enhance Mr. Helps's already high reputation. His gifts as a ready and pleasant speaker also shone conspicuously. Certainly, Mr. Helps is a force to be reckoned upon in the ranks of the younger—in the sense of still rising—members of the British gas engineering profession.

The papers read at the meeting were, on the whole, of fair, if not remarkably good, quality. Outside the Institution, however, professional attention will be attracted to the proceedings of this year chiefly on account of their bearing upon the all-important question of the possibility of restoring national unity of organization. Here it must be admitted that the meeting took the new scheme very quietly. Out of respect for the President and the Sub-Committee of the Council, who had met the deputation from the kindred Society on the matter, the proposed draft of the new rules was accepted in principle. There was no enthusiasm on the subject, as indeed was not to be expected. No company of men could be enthusiastic over the acceptance of a course of action which practically destroys their independent corporate existence. We have hitherto systematically refrained from offering any opinion as to the merits of the re-arrangement provisionally agreed upon by the representatives of the two Societies who now divide between them the personality of the gas engineering profession and the calling of gas management of the three kingdoms. Now that one of these bodies has formally given its adhesion to the scheme, at the price of surrendering its individuality, the opportunity seems a fitting one for commending this good example to the other party to the possible union, which, being more numerous, may be supposed to contain a greater variety of opinions and sentiments.

It has been truly said that the members of the Gas Institute are called upon to consent to more and greater alterations of their existing order, for the single sake of unity, than are their professional brethren of the Institution. At the same time, the members of the Gas Institute should not forget that, in consenting to abandon their own organization, the members of the Institution are indeed making the greatest of all possible sacrifices. Not to labour the point, which is better left to feeling than exactly defined, the members of the Gas Institute should take the decision of the men who once left them, or who never were with them, as a great and sincere compliment to their President and Council, who have already worked so well in the cause of unity. The most debateable questions remaining for the Institute to take into consideration are the name of the new organization, the constitution or membership, and the amount of the subscription. The question of finance is very simple. We have hesitated to say anything about it, feeling that this is a matter entirely for the members. If it pleases the membership of a club to fix the entrance fee and annual subscription high or low, that is their affair. Nevertheless, a technical organization professing to represent a whole industry differs radically from a club, and in nothing more than the ideas regulating the admission of members and the finances.

Honestly, our preference would be for the lowest possible scale of charges to members of all classes that would clear necessary expenses, which should also be cut down to the lowest working amount. Not that the remuneration of the secretariat should be stinted—quite the contrary, indeed, in the interest of efficiency. But membership should be made as little burdensome as possible on those who have most need of its advantages.

It should be clearly understood, moreover, that membership carries no adventitious advantages whatever—no certificate of competency, no claim upon municipal or other public forms of hospitality, or anything beyond itself. The harm that has been done by the "Entertainment Committee" nuisance is pretty well understood by this time; and it must never be repeated. A self-respecting man should be as ashamed to pass round the hat for his society as he would be to beg on his own account. Men will feast and make merry when they meet old friends; and long may the race of gas men have the heart to enjoy life—but not at other people's expense. All the legitimate advantages of association are surely attainable at a strictly moderate expense. So far as the existing membership of the Gas Institute is concerned, it would be an unwarrantable demand that a single eligible individual should be called upon to pay more than he does now, or to occupy a different class, merely in the supposed interest of unity. Why should he? For the future, it might be otherwise.

It is to be trusted that the question of altering the constitution of the organization by leaving out a whole order of members and associates who were made welcome in 1881 will be settled without undue regard to any awkwardnesses of handling, such as might very naturally ruffle susceptibilities. This is a very delicate and difficult business, in the conduct of which it is easy enough to trip; and we understand that a good deal of "feeling" has been created by clumsy treatment of some wholly unnecessary negotiations supposed to have been needed to clear the way to amalgamation of the Societies. If this is the case, those who perpetrated the blunder will, in due course, discover and feel their error; but it would be a greater mistake to jeopardize the whole scheme on account of some person's foolishness or thoughtlessness. The problem of drafting proper qualifications is doubtless a troublesome one to settle to everybody's satisfaction; but it should not be impossible to find a form of words that will satisfy the majority. Then it would be much better to invite applications for registry from those who can claim to be eligible, than to require others to sign themselves off. There is a right and courteous as well as a wrong and stupid way of doing these things.

Finally, with regard to the name of the new organization, nothing that is merely verbal should be permitted to stand in the way of an agreed union. We have already stated what there is to be said in favour of the title which refers to the original of all such societies. There can be nothing crisper than the present name of the older body; but if the proposed organization is to be a sectional and not a comprehensive one, some alteration of the name will become expedient. It is difficult to suggest better names than those now in use; but a different title from either of the old ones seems to be called for. The philologically-minded among our readers had better turn the subject over in their thoughts between now and next month, and send us the fruits of their cogitations. One can always decide such a matter easier for seeing the suggestion in print.

In Committee on the London Gas Companies Bill.

The Committee of which Mr. Oldroyd is Chairman resumed on Tuesday last the hearing of the promoters' case in regard to the London Gas Companies Bill. The proceedings were continued for three whole days; thus finishing the evidence in support of the proposal to legalize the portable photometer for penalty testing of the Metropolitan Gas Supply, and developing the main lines of the Companies' defence. Although the Bill does not discriminate between the three Companies to whom it would apply, and therefore the threatened undertakings have a common cause to unite their forces in opposition to it, they are acting independently on the defensive. This is probably the best way for all and sundry, inasmuch as it leaves to the many keen minds engaged in opposing the Bill complete freedom of action, while every independent success damages the common enemy. On the resumption of the proceedings, Dr. Clowes was recalled, with the object of further strengthening the case sought to be made out for the need and the merit of portable photometer testing. He was followed by Mr. Thomas Fairley, the Leeds Gas Examiner, whose evidence went to establish the identity of indications given at a Board School trial of two portable photometers. Next came Mr. C. R. Bellamy, the Liverpool Gas Examiner, whose testimony to the value and acceptability to all parties of portable photometer testing was looked forward to with much interest, by reason of the alleged fact that in Liverpool a system of this character has long been practised with the consent of the Gas Company. Mr. Bellamy duly gave out his opinion that photometric tests of gas at fixed places and times are not sufficient protection for the consumer. This, of course, is one of the main contentions which the London County Council are now endeavouring to establish. Then Mr. Bellamy was led to explain the Liverpool system; but when the story was told, it bore a very different moral to that which the general statement that the Liverpool Gas Company had accepted the portable photometer had held out to general expectation. It was confessed that the arrangement was a purely voluntary one, entered into in 1894 between the Company and the Corporation, by virtue of which the Company are relie ved from all statutory or penalty testing—to which they are liable under their Act of the year 1865—and, in substitution therefor, they consent "that the Gas Examiner of "the Corporation may from time to time send to the Gas "Company a record of the result of tests made by him by "means of a portable photometer, and that if those tests "show that the gas at the time and place of testing was "under the standard power or purity, then the Directors "undertake to thoroughly investigate the matter, and use "every endeavour—if they find reason to think that the "tests are correct—to remedy the defect for the future!" Besides, it also came out that, as a matter of fact, the so-called peripatetic testings are so only in name; it having become the practice to confine the operations to about six particular places found by experience to be suitable—informal testing-stations, in effect. Mr. Bellamy's evidence was certainly a flattering testimonial to the Liverpool Gas Company.

This completed the promoters' evidence. The Gaslight and Coke Company's case was immediately opened by Mr. Pope, who deferred his speech until his witnesses had been heard. Mr. G. C. Trewby was first called; and his calm, straightforward account of the way in which the huge output of the Company is produced and distributed, made the scarcely-veiled insinuation of the County Council—that one quality of gas is sent to the fixed testing-stations while another is supplied to the public—shrink into its proper scale and place. As to the insufficiency of the existing system and arrangement of testing at the stations, Mr. Trewby explained once more that the Gas Referees are empowered to require as many stations to be provided (at the expense of the Companies) as they please, where they please, and to keep them going every hour of the twenty-four if they please. Out of 21,259 such tests made of Chartered gas during the last five years, only two bad ones were proved against the Company. Mr. Trewby described the practical requirements for a satisfactory testing-station; and as he did so, the fancy of the County Council that a room picked out hap-hazard at any Board School would answer the purpose, faded away. When the witness came to the portentous catalogue of low portable photometer readings put in by the promoters, they wilted under his dispassionate handling. Low readings at Board Schools? Certainly—what else could you expect? The conditions are utterly inimical to reliable testing, and the results are consequently out of accord with those that are obtained at the proper testing-stations, where every care is taken to ensure accurate work. Who says that the Gas Referees prescribe anything unnecessary or insignificant in the equipment and service of the stations? Mr. Worsley Taylor cross-examined Mr. Trewby with great pertinacity, chiefly with the object of getting him to admit that his objections to portable photometer testing as proposed in the Bill would be removed if the Gas Referees were entrusted with the prescription of the class of places to be used for the purpose. Counsel failed to shake the witness's evidence-in-chief on this point. Instead, he succeeded in bringing out some new and striking observations as to the effect of the temperature of the room on photometrical experiments. Against Mr. Trewby's massive resistance, all the gimcrack assumptions and presumptions advanced by Counsel could make no headway. It began to emerge at

this stage of the inquiry that the establishment of testing stations at the gas-works would be an effectual further check, if such is needed, on the quality of the output.

On Wednesday, Mr. Corbet Woodall was called, and gave the Gas Companies' view of the nature of the parliamentary obligation under which they are to supply gas of the statutory illuminating power. He also complained of the offensive suggestion contained in the "detective" clause of the Bill, and condemned the whole scheme of the measure as flippant, crude, and unsatisfactory to the last degree. Mr. Worsley Taylor, in cross-examination, led Mr. Woodall over much the same line of country as he had taken to with Mr. Trewby on the previous day, with the same general result. Only that the "flippancy" of which the witness had accused the framers of the Bill seemed, as he went on, to infect Counsel, who led his own plea for portable testing to the *reductio ad absurdum* of the possible prescription by the Referees of a "pantechnicon "van" for the purpose. Mr. Greville Williams followed with some pertinent observations as to the determination of the illuminating power of gas being an operation of great delicacy. He illustrated and supported Mr. Trewby's point about the temperature—not as affecting the bulk of the gas, but the photometrical apparatus. He also disputed the assumption that any possible irregularity of the portable photometer might be corrected by making some predetermined allowance.

Then Mr. W. C. Young, the well-known professional Gas Examiner, gave evidence bearing upon the difficulty of securing concordant readings of portable photometers; and he was succeeded in the chair by Professor V. B. Lewes, who had originally attended the inquiry in his capacity of Chief Gas Examiner for the Corporation of London. The Corporation having withdrawn, Professor Lewes was served with a Speaker's Warrant to give his evidence at the instance of the Gaslight and Coke Company. Professor James Dewar completed the indictment of the scheme of peripatetic testing; and this strong expert evidence finished the case of the Gaslight and Coke Company. Indeed, after Mr. Pope had briefly addressed the Committee, the Chairman announced that they did not want any more scientific evidence on the subject of the portable photometer, but would prefer the evidence offered on behalf of the other Companies to be limited to their special objections to the Bill. Mr. Livesey then expounded, with his accustomed force and point, the position of the South Metropolitan Gas Company in regard to the Bill, and what had transpired during the inquiry. The temptation to comment upon this evidence is great; but it must be resisted.

[Yesterday afternoon the Committee on the Bill declared the preamble of Part 2 of the Bill—that relating to the proposed legalization of the testing of gas by the portable photometer—not proved. The Bill of the Gas Light and Coke Company will be taken by the same Committee to-morrow.]

The Question of the Price of Coal.

Mr. Helps, in his address to the Institution of Gas Engineers last week, naturally referred to the question which is of paramount interest and importance to the gas industry at the present moment—namely, the price of coal, the extraordinary rise in which was due, he said, to causes that, in his judgment, have never been satisfactorily explained. Such, we have observed, is the attitude of mind to be found among coal consumers in general, and certainly among gas managers in particular. All are willing to grant that the flourishing state of trade, the activity in the iron and steel markets, and the foreign demand for coal, are conditions tending naturally to a rise in the price of fuel; but no one can explain (so we hear on every hand) why the rise should be so enormous as, in the case of gas coal, to amount to something like 80 per cent. over last year's rates. There has been no falling off in output—1899 was, far and away, the record year for coal raising; and there has been no question of the demand vastly and patently exceeding the supply, though it is admitted that the supply has not been fully equal to the demand. Why, then, it is asked, should a moderate excess of requirement over output so immoderately increase the price?

The explanation lies, we venture to think, in a fact which is obvious, but is often forgotten—namely, that the purposes for which the bulk of the coal raised in this and every other country is employed, are such that the obtaining of adequate supplies of coal is so vital to the prosecution of the business of the user that, if there be any serious doubt as to the quantity available in the market "going round," the industrial consumer will, temporarily at least, pay any price rather than run the risk of being the one to go short. The first instinct—in the case of Gas Companies with statutory obligations to fulfil, the first duty—is to ensure supplies; cheaply if may be, dearly if must. The question of reducing the volume of business, or of shutting down entirely, is naturally the last to be considered; and, indeed, so far as the gas industry is concerned, it is beyond the control of the direct user. Railway companies, iron and steel works, steamship owners, the Admiralty, gas and electric lighting companies, take nearly one-half of the output between them. Which of these can possibly afford to wait for cheaper times, if their stores be empty and coalowners unanimously ask high prices?

That is wherein coal differs so widely in its economics from other commodities. If cigars be dear, the smoker can immediately cut down his allowance; if food go up in price, it is possible for most people—and would be well for some—to live more simply; if clothes be more expensive, the silk hat has to do duty a month or two longer. But the consumption of coal cannot be so readily adjusted to the state of the market. The restrictive tendency of high prices is slower in taking effect. One result of dear coal is, indeed, to send people to the Gas Company for a heating stove! The fact that gas is a product of coal does not always occur to the average householder; and even when the price of gas is raised, he does not really notice it until the first winter quarter's bill comes in. Then, and not before, comes the more careful consumption, and the check to gas business; so that we should not be surprised to hear of very good outputs from gas-works this side of next Christmas, if the winter be at all severe.

It is, then, the absolute necessity of immediate and constant supplies to the industrial consumer of coal, and the complete absence of stocks in the hands of either buyer or seller—a state of things inevitably resulting sooner or later from even a small excess of demand over production—that have combined to place the market at the mercy of the coalowners. In such a state of a market governed by the conditions peculiar to the coal trade, the only limit to the price demandable is the cohesive strength of the producers and the fear of competition from abroad. The price of coal this spring has, it must be admitted, been carried well up to that limit. Whether this has been wise policy on the part of the coalowners is another question. Our present point is that there is nothing mysterious about their having been able to pursue it. It is some consolation to know that riding such an advantage at top speed is certain to bring a more rapid and complete reaction than would have followed from a reasonable treatment of consumers. But it is difficult beyond measure for producers to combine to be reasonable. Each thinks only of lining his nest while feathers are plentiful.

Settlement of the Bradford Bill.

The Bradford Corporation Bill was in Committee again last week, when the promoters had to report progress in regard to the suggestion thrown out by the Chairman, before the recess, that the Corporation and the Gas Companies whom they proposed to forcibly expropriate should try to come to terms. Unfortunately, the only possible report was that matters had come to a deadlock, with the sole exception of the case of the North Bierley Company, who had agreed to sell. The Airedale and Eccleshill Companies stood out for certain terms which they said they understood the Corporation had been willing to give, but of which, when it came to the point, the Corporation denied all knowledge. Thereupon, in accordance with the hint given before Easter, the Committee declined to entertain the proposal for compulsory purchase of the undertakings against the desire of the Companies. On the question of principle, the decision is to be warmly applauded. It is one of the most valuable precedents on the point that has ever been given by a Parliamentary Committee. As regards the particular interests of the objecting Companies, it is probable that they are sorry they overstood their market. It is too late now. There is every reason to believe that the terms which the Corporation of Bradford were prepared to offer to the Gas Companies were better than they may feel disposed to give again, if only for the sake of rounding off their tedious and expensive extension scheme. We have been accused

locally of putting the claims of these Companies to generous treatment on too high a level. We have never ventured to price the property, however, and can say, once and for all, that we should have been disposed to esteem fair and reasonable any firm offer which the able advisers of the Corporation in this business might have found themselves in a position to support in the circumstances. As it is, the Companies are to be pitied in one sense, although all other Gas Companies must rejoice that through them the principle of the sacredness of private property has been defended. We would not be misunderstood on this point. Of course, private gas and any other description of real property is subject to the power of Parliament to order a compulsory purchase by the public body in the public interest. But this is a very different matter from the idea that a trading Municipality, with reference to its trade interest, should have greater privileges than anybody else in trade for compulsorily acquiring a coveted concern. It is to this idea that Lord E. Fitzmaurice's Committee have entertained so strong an objection; and for their decided action in discountenancing it, all Gas Companies will be sincerely thankful.

The Affairs of the Imperial Continental Gas Association.

THE business at the half-yearly meeting of the Imperial Continental Gas Association last Tuesday consisted practically entirely of the interesting comments of the Chairman, Mr. T. H. G. Newton, on the full report on the affairs of the Association presented by the Board, and given in another column. It may therefore be assumed that, though the effects of the troublous times through which the undertaking has lately passed are clearly seen from the Directors' statement, they are not regarded by the proprietors as being of such a nature as to call for criticism of the management. And, in point of fact, such criticism would be unfair, as, owing to the ability with which the business has been conducted, the loss sustained by the Association through the acquisition of the Amsterdam station by the City and the establishment of municipal gas-works by Vienna has been compensated for by an increased production of gas at the other stations to the extent of an average of 7·83 per cent. Of course, the Chairman had much to say on the coal question, which is a serious one enough for Gas Companies in this country, who have the power of raising their charges to meet the extra outlay for their raw material, but is a far more important matter for those abroad, who work under the concession system. With a hard-and-fast price fixed at not too high a figure when coal is cheap, a company may have the pleasure of contemplating the absorption of all their profit when coal is dear. Mr. Newton brought this point home to the shareholders by stating that a rise of 6s. per ton net would be equivalant to the Association paying £120,000 more for coal in a half year, and that, as a consequence, the profits would be reduced by this amount. But he reassured them by reminding them of the existence of the Association's equalization of dividend fund, amounting to nearly a year's dividend at the rate of 10 per cent. Though dear coal may necessitate a temporary dip into this fund, Mr. Newton looks forward confidently to the time when, the prevalent famine over, the stations still in the hands of the Association will, without strain, be equal to the provision of the customary dividend.

American Coal for Russia.—According to a Reuter telegram despatched from Philadelphia on the 3rd inst., and published in the "Financial News" on Friday, the steamship *Accomac* will shortly carry 3500 tons of anthracite coal to Kronstadt; being the first consignment of a large quantity destined for the Russian Baltic ports. So far as can be recalled, this is, says the telegram, the first shipment of anthracite sent to Russia.

The Consumption of Gas in Paris during the Exhibitions.—In the year of the first Exhibition in Paris (1855) the annual consumption of gas in the city was about 1440 million cubic feet, of which the Exhibition and public buildings only used a very small portion. In 1867, however, the annual outsend was 4820 million cubic feet, of which no less a quantity than 503 million cubic feet was burnt at the Exhibition for illumination. In 1878 the consumption was regarded as fabulous—732 million cubic feet out of the annual total of 7484 millions. In 1889 the total bulk of gas sent out was 11,023 cubic feet—the maximum hitherto attained; but, at the Exhibition, only 512 millions were burnt. For 1900 the total consumption in the city is estimated at nearly 35 million cubic feet per diem; the total to be used during the Exhibition, with its illuminations and extraordinary consumption, being estimated at about 883 million cubic feet. This will be the maximum attained since the invention of gas.

INSTITUTION OF GAS ENGINEERS.

PROCEEDINGS AT THE GENERAL MEETING,

HELD AT THE

INSTITUTION OF CIVIL ENGINEERS,

MAY 1ST AND 2ND, 1900.

Mr. J. W. HELPS, M.Inst.C.E., of Croydon, President.

REVIEW OF PROCEEDINGS.

The meeting of the Institution of Gas Engineers began, under most favourable auspices, last Tuesday. The weather was perfect, and the attendance tolerably good. Mr. F. D. Marshall, the Retiring President, took the chair betimes; and the small amount of preliminary business was quickly disposed of. Several new members and associate members were added to the roll of the Institution. Upon his retiring from the chair, Mr. Marshall was awarded the warmest thanks of the Institution for his conduct in the presidential office. Without delay, Mr. Helps proceeded to deliver his Inaugural Address, which we published last week.

The general verdict on the Presidential Address will be that it was worthy both of the speaker and of the occasion. Whether or not it is fated to be the last of the list of addresses with which the "few but fit" constituency of the Institution of Gas Engineers in its present form has embellished the literature of the profession, it deserves to be classified among the best extant models of this order of composition. This is no mean praise, seeing that for years past the standard of this class of writing has steadily risen. The present is not the occasion for discoursing at large upon the way in which the address of a president of a gas engineers' society should be written. It is enough to say here that Mr. Helps has successfully realized much of the desire of the most critical students of this order of technical literature, who are in the habit of demanding a satisfying dish of facts, as fresh as may be, piquantly flavoured by a personality.

The President began by making quite clear his position in respect of the amalgamation proceedings. Safely basing himself on the sound contention that a duplication of national technical Institutions is "unwarranted," he went on to argue that the superfluity of professional organizations is apt to become a positive hindrance to the advancement of the best of those interests which such organizations are meant to subserve. Much of what the President had to say in this part of the Address is better discussed in connection with the subsequent debate upon the proposed reunion.

Naturally, the first technical point taken up by the President was the extraordinary rise in the price of coal, which he regarded as quite unjustifiable, and as due to causes which have never been satisfactorily explained. In this trenchant declaration, Mr. Helps only expressed the common opinion of his audience. No generalities of the so-called science of Political Economy will suffice to recommend such an increase in the price of coal as the country has had to pay these last two years. It is possible to understand how and why a commodity like coal or oil, which is at once a necessary of civilized life and a staple product of the country, may grow progressively dearer as the supply falls off. We have had plenty of academic assurances that this is the way in which the inevitable exhaustion of the native coal resources will begin to make itself felt. There is to be no sudden leap upward to famime prices; but British coal is to become ever dearer and yet dearer as the expenses of winning it grow heavier, and the best and most easily-worked seams are emptied one after another. With all due respect to the academic Economists, be it said, the British gas manager could stand this gradual enhancement of coal values fairly well; especially as the most alarmist predictions on the subject (such as those of Mr. Forster Brown, which we were discussing in the "JOURNAL" at this time last year), put fifty years hence as the nearest date for the bad time coming. English gas engineers have never yet seen any good cause for lying awake o' nights to ponder the eventuality of the exhaustion

of the native coal measures; but they have in many cases this year passed through some "bad quarters of an hour" in consequence of the difficulty of getting supplies, and the exorbitant prices asked by the contractors for renewal engagements. Most of us fail to see any Political Economy in all this. Gas managers call it simply hard bargaining on the part of the coalowners—all very capital for them, no doubt, but only rendered possible by the coincidence of foreign demands and the circumstance that gas coal contracts must be made at the regular season. If this view turns out correct, coal prices are bound to tumble before the summer is out.

Mr. Helps fears that the necessary step of putting up the price of gas to partly meet the advanced cost of the raw materials of manufacture will have a prejudicial effect on the consumption of gas. This is not greatly to be feared. A patently temporary increase in the cost of a necessary of life, for market reasons, does not have the same effect on the demand as a constant, rooted conviction in the public mind that the commodity is kept dear through the unwillingness or inability of the privileged vendors to sell it cheap. It is as well to make this point, because otherwise it is possible that some whose judgment is not wholly to be trusted in this regard may argue from the possible fact that a temporarily raised price of gas does not noticeably check the demand, to the false conclusion that the people do not care whether gas is cheap or dear. The truth is that, in the long run, they do care, and show it; but they will pay more for it at a pinch, with a grumble. What is unfortunately more to the point is the reflection that if the price of coal does fall heavily this summer, the value of coke will go down as well, and the gas manufacturer will be hit in two tender places at once.

The President's careful exposition of the economics of carburetted water-gas manufacture, for enrichment and auxiliary purposes, was a valuable addition to the available stock of information on the subject. To this he added a novel supplement in the shape of a statement of the points in regard to which carburetted water-gas compares unfavourably with coal gas. This new departure leads straight into that debateable land where the gas calorimeter looms larger than the photometer. The pioneers into this country are few; but they will have a numerous following ere long. Oddly enough, the President stopped short of making the discovery to which all his prospecting pointed—the supreme importance of the calorific value of town's gas. Still more remarkably, he even "threw back" to the suggested desirability of the introduction of a "burner of the ordinary type"—meaning, it is to be imagined, of the luminous-flame kind—for improving the illuminating power of the mixed gases. To this suggestion it is possible to reply with all emphasis, Never! The incandescent, which is nothing but a fuel-gas burner, is too far ahead of any known luminous-flame burner to encourage any hope that the latter can ever be brought up alongside of it, with any kind of town's gas.

Next, the President warmed to his work of grappling with the naphthalene problem, with which—as he would admit with a sigh—he is only too much at home. There has always been naphthalene in the Croydon town's gas, he remarks; and the tenour of his observations seems to bear the interpretation that he believes there ever will be. Many of the passages of the address dealing with this puzzling question, while conveying much definite information, are even more valuable for their element of suggestiveness. Take, for example, the remark that at certain times the illuminating power of the gas suffers no reduction in travelling from the works to the testing-station in the town, two miles distant. How often has the question indicated in the latter part of the statement been raised—generally without a thought that the answer might be affected by any consideration of time or season?

Indeed, this part of the address strikingly recalls the profound observations of another President, Sir Michael Foster, at the Dover meeting of the British Association. The gas industry, on the other hand, affords a good illustration of the state of science, and of the mind of the scientific inquirer, contemplated by Sir Michael Foster. He said: "The truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting, than man, unscientific man, who is often content with 'the nearly,' and 'the almost.' Nature never is. It is not her way to call the same two things which differ, though the difference may be measured by less than the thousandth of a milligramme or of a millimetre, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct. If he, in carelessness or in disdain, overlooks the minute difference which she holds out to him as a signal to guide him in his search—the projecting tip, as it were, of some buried treasure—he is bound to go astray; and the more strenuously he struggles on, the farther will he find himself from his true goal."

So the gas industry is a business the main lines for the conduct of which are familiar to the merest tyro. But it has its mysteries which the most expert practitioner can never fathom; and the puzzle of naphthalene is one of these. The importance of the question is of the first magnitude, inasmuch as it involves the point of reliability of the supply. All the indications so far go to show that a complete understanding of the subject will be the prize of him who, as Sir Michael Foster says, takes heed of the smallest significant evidence. There is surely something at Croydon or at Redhill to account for the apparently irreconcilable behaviour of naphthalene at the two neighbouring places.

After a brief return to the carburetted water-gas factory for the purpose of giving his views on the vexed question of the relative advantages of leaving the carbonic acid in and taking it out, the President explained the position of the two prepayment systems in vogue in the Croydon and Carshalton districts. It is interesting to note that he awards the preference to the less fashionable, but older system, which, we believe, is that accredited to the name of Mr. W. A. Valon. The President's testimony should at any rate serve to remind the technical world that there are at least two methods of popularizing gas among the large class of consumers whom it is expedient to deal with on a strictly cash basis. This candid piece of evidence brought to a conclusion an address which cannot fail to enhance the President's reputation of being a gas engineer of singularly well-balanced mind and clear views, with ample gifts of pleasing and convincing exposition.

After the manifestation of approval which marked the termination of the Address, the President again rose and entered upon a very complete explanation of the proceedings connected with the drafting of the proposed rules for a united organization. Thanks chiefly to the President's tactful style of dealing with the thorny parts of the subject, only little (and that a very mild) discussion took place on this occasion; the meeting accepting unanimously the principles of the solution proposed by the Joint Committee.

The first paper to be read was Mr. Livesey's somewhat argumentatively-named presentment of the case for correcting the character of English town's gas by dropping the practice of enrichment. This and Dr. Colman's paper on gas calorimetry, and Mr. C. C. Carpenter's communication on the carbonizing plant at the Bankside works, filled up the first day very profitably. Unfortunately, the fact that the Committee on the London Gas Bills reassembled on the same day after the recess, took away a notable contingent of leading members of the Institution.

Wednesday's business commenced with an impressive lecture by Professor Vivian B. Lewes, on the most recent developments of water-gas technics. This was quite one of Professor Lewes's best efforts, and was most attentively followed and warmly applauded. It contained a suggestion of practical improvement in carbonization which seems calculated to have important consequences to the industry.

The remaining papers were taken afterwards. They all contained points of interest, some of which will conveniently come forward for further discussion later. Altogether, so far as the technical quality of the Institution transactions is concerned, this meeting was a distinct improvement on the last, although none of the papers, with the exception perhaps of Mr. Livesey's, can be truly said to be addressed to the consideration of subjects of the first importance. And even this paper only opened up questions which must be answered elsewhere.

The dinner of the Institution on Tuesday, at the Café Royal, was a very pleasant function. The principal guests were Dr. Haldane and Dr. Clowes. The excursion to Woolwich, to inspect the Arsenal and Royal Laboratory, and the subsequent drive to the Crystal Palace, was well conceived, and was but slightly marred by showery weather.

THE PROCEEDINGS SUMMARIZED.

[*The usual full Report commences on p.* 1190.]

A brilliant May-day morning, important business, and the expectation that this might possibly be the last annual meeting of the Institution of Gas Engineers as such, no doubt all contributed to the bringing together of the good attendance at the opening sitting. There were gentlemen present whose names appear in the early reports of the old British Association of Gas Managers; several who are members of both the Institution and the Institute; and others who are only members of the latter body—but all of whom will, it is hoped and believed, soon be members of one united association.

There was only a little formal business calling for attention—simply the adoption of the report and accounts, and the Scrutineers' report—before the retiring President (Mr. F. D. Marshall, of Copenhagen) vacated the chair. In two or three of those happy phrases which he has always at command, he introduced his successor (Mr. J. W. Helps, of Croydon); at the same time expressing the hope that if he had, during his own year of office, left undone anything that he ought to have done, the members would pardon him. There was no room for doubt as to the opinion of the members on the point; for they very heartily endorsed the encomiums passed upon Mr. Marshall's services by Mr. Foulis and Mr. Lacey.

The New President and His Address.

The entrance of Mr. Helps into his high office was marked by much enthusiasm. He at once proceeded to deliver his Inaugural Address, which was published last week, and is commented upon in the foregoing "Review." It is therefore unnecessary to further deal with it here. The honour of thanking the President for his address fell to Mr. Fletcher Stevenson, who referred first to the many points in the composition which merited study on the part of the gas profession, and, secondly, to the full confidence that the members have that their President will guide them safely through the critical time before them. The well-expressed sentiments of the speaker were heartily approved.

Unity and Amalgamation—The Scheme Adopted.

An acknowledgment by the President of the thanks of the members led to the item on the *agenda* in which, of all other matters for the time being, perhaps the greatest general interest is taken—that is, the now well-advanced project for amalgamation with the Gas Institute. The results of the conferences up to the present point, and the rules which have been framed as a basis on which the two bodies may become one, are matters of public knowledge; but the President, to pave the way for discussion, gave a *résumé* of what had been done. He showed that the Council had in no way pledged the members to any special course. All they were asked to do on this occasion was to approve of the Council's action and also of the rules; and then, if the scheme were adopted at the meeting of the Gas Institute, another meeting of the Institution would be immediately called, in order to pass a resolution for dissolution. He appealed to the members, in expressing their opinions, to keep the welfare of the gas industry prominently in the front. The discussion was appropriately opened by Mr. George Livesey. To see the gas industry thoroughly united, he said, had been one of the objects he had wished for for many years. Evidently with a desire to give honour where honour is due, he mentioned what is now a matter of history—the mediation of Mr. Charles Sellers and the honourable action of Mr. George Bray which had removed a barrier to reunion. The rules and suggestions, Mr. Livesey regarded as most complete and comprehensive; and the only improvement he could suggest was that some provision should be made for enlisting the pecuniary support of gas undertakings, both companies' and local authorities'. Mr. Foulis fully concurred as to the wisdom of joining the Institution and Institute, and characterized the rules drawn up by the Joint Committee as "admirable." He thought, however, it should be perfectly understood that there must be no attempt to go beyond these rules. The Joint Committee were congratulated by Mr. T. Banbury Ball upon the rules; and Mr. Charles Hunt also expressed his approval. For the consideration of the Council, he suggested the desirability of admitting to the Council of the new Institution the Chairmen and Secretaries of any Local Sections that might be formed; and he favoured as the title for the new body "The Institution of Gas Engineers and Managers." Mr. S. Y. Shoubridge, pointing out that the new rules excluded the associate and extraordinary members of the sister body, was anxious to know whether they had been consulted; but obviously this was a question for another time and place. As one of the original members of the fast-thinning ranks of the old British Association of Gas Managers, Mr. Robert Morton was glad to hear of the probability of there being a fusion of the two bodies. Mr. W. R. Cooper was afraid that, if they held out a "cast-iron" set of rules to the Institute, as suggested by Mr. Foulis, they would not be adopted by that body. With gratifying unanimity, a resolution, proposed by the President, and seconded by Mr. Fletcher Stevenson, was then passed, recording the opinion of the members that it was to the best interests of the industry that amalgamation with the Institute should be brought about, approving of the action of the Council and of the rules drawn up, and desiring that the necessary steps should be taken to carry out the proposed scheme in accordance with the rules as submitted.

This momentous question satisfactorily disposed of, the members settled down to the consideration and discussion of the papers. The first one was on

The Enrichment of Coal Gas.

Mr. George Livesey was the author, and it will be observed that he has somewhat modified the title since the issue of the programme by the elimination of the expressive word "adulteration." The question raised by the author is whether the object of gas manufacturers should not be to supply gas at the lowest possible price regardless of its illuminating power—in fact, he goes further, and asks whether the time is not within measurable distance when non-luminous gas will be the great *desideratum* of the public. If so, and if the best is to be done to meet the needs of the consumers of gas, ignorance and prejudice must be conquered, and the policy of half a century reversed. He examines the three systems of enrichment in general use, and inquires into their relative effectiveness as to uniformity, reliability or permanence, and cost. The conclusion he comes to is that there are serious objections to all three systems; for while the cost of cannel puts it out of court, spirit is useless from its want of permanence, and carburetted water gas is objectionable from its nature and the difficulty and uncertainty of mixing The recent more than doubling of the price of oil (which Mr. Livesey thinks is far more likely to be permanent than the present increase in the price of coal) will, in his opinion, very likely render the continuous use of carburetted water gas impracticable. He asserts that no one can seriously argue that the slightly higher calorific value of enriched gas, even if the enrichment reaches the consumer, is desirable for either heating or manufacturing purposes. A lower price rather than the higher quality is what consumers want; and as to incandescent lighting, experiments made in Germany, and corroborated in England, have proved that, with a Welsbach burner, the light actually increases as the illuminating power of the gas diminishes. Consumers, he points out, have it in their power, even with ordinary burners, to increase or diminish the light obtained from the gas to a far greater extent than the difference produced by enrichment. Another strong reason against enrichment is that the best kinds of gas coal are now getting scarce, and inferior gas-making seams are becoming more and more the source of supply. If, therefore, the policy of pressing for higher illuminating power is continued, or even the present standard is maintained, the cost of gas must rise, and gas undertakings must necessarily drift more and more into the power of the coalowners. Towards the close of the paper are a few timely words of warning to these gentlemen.

Although the speakers did not confine themselves to the main point and object of the paper, the discussion contained many interesting features. Mr. Foulis related his experience in dropping the illuminating power of the gas in Glasgow from 25 to 20 candles, and pointed out that the fears entertained by some people that the pipes would be too small for the lower-quality gas, and that the accounts would be increased, proved groundless. Mr. S. Meunier agreed that in industrial centres "a lower price rather than a higher quality is what the consumers want;"

and Mr. W. R. Herring held that the illuminating power of the gas supplied should be the cheapest that could be produced from the gas coal in closest proximity to their own locality. A notable point in Mr. Herring's remarks was the statement that, under his coal contracts, the difference in cost between the 15-candle gas from common coal and the 25-candle gas supplied was only about 3d. for the 10 candles. The common coal cost hm 15s. 6d. per ton; the cannel, 28s.; and the average cost of the coal used worked out to 18s. 6d. per ton. Mr. James Stelfox, referring to the author's remarks on water gas, pointed out that the rise in the price of coal amounted to much more than the increase in the price of oil. Mr. Samuel Glover criticized several points; but generally he saw many objections to the illuminating power of gas being altered from what people were accustomed to. Mr. C. E. Botley found it cheaper to enrich by cannel last winter rather than by carburetted water gas; and he thought that testing for illuminating power should not be enforced, but only testing for impurities. Mr. Marshall made some interesting remarks, which disclosed his view that the days of cheap oil have departed never to come again. Mr. E. A. Harman made a few remarks on the question of coal; and Mr. Charles Hunt agreed with the policy enunciated in the paper as a measure of permanent economy. In time, they were going to be told, gas would be judged not by its illuminating power but by its heating qualities. In his reply, Mr. Livesey further emphasized some of the points in his paper. What Mr. Marshall had told them about oil confirmed the information he had been able to gather himself; but he did not believe the price of coal would be permanently high.

The Calorific Power of Illuminating Gas.

The second paper was by Dr. H. G. Colman, and it is a perfect companion to that supplied by Mr. Livesey. The author's aim is to show that a large and constantly increasing proportion of the output of gas is employed for purposes in which the calorific power is of greater importance than the illuminating power; and, therefore, the necessity for an accurate knowledge of the former has largely increased. It is, indeed, in Dr. Colman's opinion, quite possible that before long the heating power of the gas supply may become of even greater importance than its illuminating value. After several years' experience, the author pronounces the Junkers calorimeter to be an instrument that does afford a quick and accurate method of ascertaining the heating power of gas. From the point of view of testing, he maintains that the determination of the latter is much more satisfactory than that of the former. In spite of all improvements, an absolutely accurate and constant standard of light has yet to be discovered; and, further, illuminating power varies according to the construction of the burner employed, and the rate at which the gas is consumed. Moreover, the unavoidable personal error is much greater in determining the equality of the light of two illuminated surfaces than in reading off the height of a thermometer, or in measuring the volume of the weight of water used, as in the case of the calorimeter. The author gives, in tabular form, a number of results obtained with the instrument, together with the illuminating power of the gas examined; the chief object of the investigation being to determine the manner in which the calorific power of gas corresponds with the light-giving power. We will not attempt to summarize his figures here; but one or two points affecting water gas are especially interesting. It is usually stated that carburetted water gas has about 5 per cent. less calorific power than coal gas of the same illuminating value; but, from Dr. Colman's results, it would appear that for the quality of gas experimented upon—16·5 to 18 candles—10 per cent. is more nearly correct. He also brings out the point that the admixture of 10 to 20 per cent. of carburetted water gas does not affect the calorific power to an extent which will materially interfere with consumers. Tests made with coal gas at the works and two miles away also reveal the fact that there is no falling off in the calorific power of the gas through traversing the main. These are only a few of the features of an extremely interesting paper.

The discussion was to the point. Mr. Hunt was afraid Dr. Colman had not arrived at a satisfactory ratio between the calorific value of gas and its illuminating power. He noticed in one of the author's tables that the two gases of lowest illuminating power—16·47 and 16·34 candles—gave the highest number of calories per candle, and the gas of highest illuminating power—18 candles—gave almost if not quite, the lowest; and in another table it was very marked. The conclusion to be drawn from this was that the heating value of gas of low illuminating power was greater in proportion than gas of high illuminating power. Mr. Marshall believed the calorimeter should be used with the photometer. He said they found it a vast help at their works in checking the "personal error," which could not be avoided in using the photometer. He was astonished that the calorimeter was not used to a greater extent in English laboratories. Figures which Mr. Marshall gave confirmed the previous statements—that the lower the illuminating power, the greater the efficiency in the calories developed per cubic foot of gas consumed. He also urged the importance, in ordering a gas-engine, of letting the makers know the average calorific value of the gas; and he believed the day would soon be past when gas manufacturers would pin their faith to the photometer. Mr. Forbes Carpenter also remarked upon the usefulness of knowing more of the calorific value of gas with its growing use for power purposes. Some comparative calorimetric tests made by Mr. Leicester Greville were quoted by Mr. William King; but he did not comment upon them. It seemed to Mr. Harman that one of the long-established convictions of gas managers—that gas lost in illuminating power at a distance from the works—was being knocked on the head. He thought it was generally conceded by gas-engine users that the better the illuminating power of the gas, the easier it was to work the gas-engine. In connection with a question put by Mr. D. H. Helps, it was considered possible by the President that the constituents added to a gas to increase its illuminating power, or which were in the gas of a high illuminating power, might have something to do with the lower calorific value of the gas—that was to say, that the added constituents might not be so high in calorific power as those of a gas of low illuminating power. Dr. Colman, in reply, dealt fully with the various points raised; and he emphasized his assertion that errors are far and away greater with the photometer than they are with the calorimeter.

Inclined Retorts at Bankside.

The next paper was by Mr. C. C. Carpenter; and it was very generally regretted that his duties in connection with the County Council Gas-Testing Bill in Parliament prevented him being present to deal with the severe criticism to which the inclined retort installation at Bankside was subjected. The settings were designed to fit an existing building as it stood; and this explains certain characteristics of the arrangement. There are eight retorts in a setting, four high in two vertical rows. The retorts are 20 feet long, and provided with one 6-inch ascension-pipe at the lower end. The author, for reasons stated, decided against taper retorts, and adopted parallel ones—a modified D; the minimum of radius being given to the lower corners. They are 24 inches wide, sides 7 inches high, and rise of crown 6 inches, set at an angle of 32°. The setting itself is completely divided by a middle wall into two independent sections; this being a ready means of adjusting the heat requirements either of the upper or the lower portions. Each producer supplies gas to three settings—that is, to 48 mouthpieces. The producers occupy the space under the charging-stage, and are quite independent of the retort-benches, to which they supply their gas by 18-inch cast-iron pipes. The weight of coal carbonized is ten times that of the fuel put into the producer. The coal-charging shoots are arranged after the Brentford pattern. Only the lower door of the measuring-chamber is operated by hand; and the upper doors are attached by means of a long rod to a crank-pin fixed to give the required stroke on a worm-wheel. The worm-wheels are in right and left handed pairs, driven off corresponding worms keyed upon a longitudinal shaft running the length of the bench. The entire set of doors is operated by one of West's smallest-sized motors. The coal is brought into the retort-house by an overhead railway. At the discharging end of the settings, the bottom row of mouthpieces is worked entirely from the ground—the three upper ones from a light trolley, the wheels of which run on metals kept clear of the coke heaps during each "draw." The retorts were put to work during February, 1898. High and regular heats were obtained, and charges averaging 6½ to 7 cwt. were worked off with ease. The make of gas per ton, however, fell. Long and careful investigation was made; and eventually it was found that,

no matter how carefully the coal was laid, in the process of burning off it slid down to the lower extremity of the retort. The next step forward was to trace this effect to certain kinds of coal, and a selection was made of those varieties which gave no trouble. The make of gas rose to about 10,300 cubic feet per ton; and it has remained at about this figure since. The paper includes the expenses of working; and the author states that the entire installation cost from the floor-line slightly under £14,400, or (say) £100 per 20-foot retort.

In opening the discussion, Mr. Herring described the paper as an elementary treatise on a subject which had now become old. He could not see why Mr. Carpenter did not adopt settings of nines; but he agreed with him that the advantages of the taper retort were not what appeared on the face. As to the outside producers, he could not see that they could be any cheaper than inside ones; and he should like to have some comparative figures as to their cost of working. In his opinion, Mr. Carpenter had not employed the best charging-shoot; and as to the mechanism used to operate the measuring chambers, the author had introduced unnecessary complications in a process that was intended to do away with mechanism. Mr. Carpenter also appeared to have overcome the "slip" in the same way that everybody else did. Mr. Marshall stated that with taper retorts he had found over-carbonization at the top point, and did not get the charge properly carbonized at the bottom. In his own case, he found the slipping due principally to fine coal; and by using coal in a larger condition it was easy to avoid slipping. He also wondered why Mr. Carpenter adopted eight retorts instead of nine; and he considered that in studying the author's diagrams they were making a retrograde movement. The experience of Mr. R. Brown was that equally good results were obtained with retorts of the same size throughout as with tapered ones; that he had no difficulty with the creeping of coals; and that inclined retorts did not cause depreciation of illuminating power. A few remarks on the general question by Mr. Meunier were followed by the most severe criticism of Mr. C. E. Brackenbury. He was anxious to know why the London gas engineers lagged so much behind their provincial brethren in the matter of inclined retorts; and, further, he wished to be enlightened as to what guided Mr. Carpenter in putting up such an installation as the one described. Taper retorts, he also remarked, must have taper heats; and this seemed a little inconsistent. The measuring chambers adopted by the author were really beyond comprehension. In a ground-floor house, there must be a great deal of wasted labour and money spent; and going back to a single-stage house was a retrograde step. He had had experience with 15-feet retorts; and he always understood the slipping of the coal depended upon the angle at which the retorts were set, and on the nature of the coal. At the Continental works where he had had experience, the average make, using fine coal, was 10,600 cubic feet of 17½-candle gas. Mr. Marshall interposed that, in his experience, the length of the retort had nothing to do with the slipping of coal. Mr. J. Tysoe explained that the installation had been successful in its results. The station was previously one of the dearest of the South Metropolitan Company in regard to carbonizing wages. It was now one of the cheapest; and much credit was due to Mr. Carpenter for the way in which he had carried out the work in the face of great difficulties. It was also pointed out by Mr. Shoubridge that Mr. Carpenter did not set this up as an ideal installation of inclined retorts; the space at command at Bankside being very cramped indeed. In his (the speaker's) experience, tapered retorts justified their introduction; they did facilitate the discharging.

This concluded the first day's proceedings; and in the evening the members dined at the Café Royal.

The summary so far has shown that the meeting was full of matters of technical interest; but Wednesday morning opened with one of its brightest features. It was a lecture by Professor Vivian B. Lewes, delivered with his well-known fluency, without a note before him. The title he gave to the discourse was

Water Gas, and Its Recent Continental Developments.

The lecturer first traced the gradual growth of water gas during the past ten years, in which growth there had, he said, been a doubling of the amount of water gas produced for the same amount of carbonaceous fuel used. Then came the engrossing part of the lecture. He entered upon it by referring to the great decline in the price of benzol from 15s. to 5½d. and 6d. per gallon. The process of coking coals for metallurgical purposes had brought this about. From the coking furnaces, more than 5 million gallons per annum were being produced; and the quantity might increase fourfold during the next few years. At Königsberg, benzolized water gas had been introduced. Two Dellwik-Fleischer generators had been put up, each capable of producing 20,000 cubic feet of gas per hour. The benzol was converted into benzol vapour and allowed to flow into the water gas in constant quantity as it passed from the relief holder; the benzolized water gas and coal gas being mixed at the entrance to the main gasholders. The illuminating power of the finished gas was from 18 to 19·5 candles. At Erfurt, the blue water gas was passed into the foul main during the process of gas making. This resulted in the use of less benzol, as the water gas took up some of the benzol in the tar vapours. As to the expense of manufacture, supposing 16-candle coal gas cost 11d. per 1000 cubic feet in the holder, and it was intended to increase the quantity by 25 per cent. Then 7500 cubic feet of coal gas at 11d. per 1000 cubic feet would be equal to 6s. 10½d.; and 2500 cubic feet of gas produced by the Dellwik process, at 3½d., would be 8¾d. In mixing the two gases, the illuminating power would be brought down from 16 to 12½ candles. In order to raise it again to 16 candles, they had to put in a gallon of benzol per 10,000 cubic feet of the mixture; and the benzol cost at Königsberg about 10d. per gallon. Then putting the charges on the carburetting apparatus, &c., at ¾d., they had 8s. 6d. as the price of the 10,000 cubic feet, which worked out to 10·2d. per 1000 cubic feet. So that nearly ¾d. per 1000 cubic feet was saved, and the same illuminating power obtained as at the start; and this, taking the benzol at the price of 10d. per gallon. Professor Lewes showed that the figures could be absolutely verified. In benzolizing in this way, gas managers had a great prospective advantage; the enrichment only costing 0·3d. per candle per 1000 cubic feet. When coal gas was mixed with carburetted water gas, the flame was shortened. A 16-candle coal gas gave a 3-inch flame; but when the 16-candle gas had been obtained by carburetting with water gas, the flame was only 2·6 inches in length. With the benzolized water gas at Königsberg, he could not detect any difference in the height of two flames of equal value from coal gas and coal and benzolized water gas; and no trouble had been experienced there in regard to the carrying power of the gas. Carburetted water gas had in the past ten years lent great aid to gas manufacturers; but the unfortunate rise in the price of oil had limited its utility. It looked very much now as if benzolized water gas was going to take its place. But were there no means within the four walls of the gas-works that they could bring to their aid? It was all very well to go to outside enrichment of this character; but directly a big demand was created, there would be an upward movement. Had it ever occurred to gas engineers how small an amount of change had taken place in their process of carbonization? In that process he thought there was some point that could be altered. In the formation of coal tar in the retort, they had going on a process of the greatest complexity; and one of the most promising points in the whole of the manufacture of gas was the prevention of the formation of part of that tar. The formation of that portion of the tar which came from the overheating of the gas could be prevented. At the present time, at one end of the retort the coal gas was hurried out; and the gas from the other had to pass over some 10 feet of heated surface. Between the two ends of the retort, the gas passed out at every conceivable rate—there was no uniformity; and that was what must be altered to prevent the formation of part of the tar. In White's hydrocarbon process of the early '50's they had exactly what was wanted. They had the power of doing in a proper way what White had tried to do and failed. Make, said the lecturer, your water gas, lead it to the relief holder, from there by a main to the front of the bench of retorts, and then pass the gas to each mouthpiece, where it can be led in by the side of the ascension-pipe, and along the crown of the retort to the back end. On the underside of the delivery-pipe, small holes are drilled, and means provided for regulating the supply of water gas in accordance

with the make of the coal gas. The water gas would be superheated by travelling up the retorts; and it would hurry up from the retorts the gas from the coals undergoing distillation. Though the experiments he had made had only been on a small laboratory scale, from what he had seen he thought by this means gas managers could get something like a 40 per cent. gain. If they could by this process make 13,000 or 14,000 cubic feet of gas of the same or a candle better illuminating power from their gas coal, they had a factor which would enable them to look with more equanimity on the present position.

The foregoing is merely a short indication of the points of the lecture prepared from notes made during its delivery; but it sufficiently shows that the full text published elsewhere is packed with interest for the gas manufacturer. For the lecture, which was listened to with rapt attention, Professor Lewes was heartily thanked.

Naphthalene in Coal Gas: Its Detection and Extraction.

At the close of the lecture, attention was called for Mr. Wilfred Irwin, who had undertaken a paper on the above subject. As its preparation proceeded, the scope widened; and the author dealt with the whole question of condensable products in coal gas. His remarks under this head we must leave to the reader's study when the text of the paper is published. It is to be gathered that the author's opinion is that the naphthalene trouble is entirely dependent on climatic variations—always supposing, of course, that ample condensing power exists at the gas-works. His connection with the Burnley experiments, in conjunction with Mr. J. P. Leather, forms the subject of the most attractive part of the paper from a gas engineer's point of view. To prevent the deposits, he suggested the washing of the gas with oil, to which a quantity of benzene is added to prevent any deterioration in the quality of the gas. To first obtain an approximate idea of the amount of naphthalene in the gas, the author proposed the passing of a large volume—say, 400 or 500 cubic feet—through benzene or toluene contained in two absorption flasks consecutively. In this operation, all the higher boiling hydrocarbons are caught in the flasks, and benzene takes their place in the gas. The contents of the flasks are submitted to fractional distillation through a dephlegmating column, and the naphthalene is crystallized out from the last residue by cooling. By this test, the Burnley gas was found to contain 0·13 lb. of naphthalene per 10,000 cubic feet. Experiments with a spare scrubber and various oils showed that oil will absorb naphthalene from the gas until it contains 10 per cent., when it has to be changed. Hence it follows that, according to the temperature, from 13 to 40 gallons of oil per million cubic feet of gas is the amount necessary to extract the naphthalene, and the addition of rather more than 8 per cent. of benzene prevents any loss of illuminating power in the gas. Briefly, the process patented by Mr. Leather and the author jointly is this: That the gas, after it has been thoroughly cooled and freed from tar, is treated with a small quantity of a mixed liquid capable of absorbing the naphthalene, and which, at the same time, will not deteriorate the quality of the gas by absorbing benzene or other illuminating substances therefrom. Suitable mixtures are blast-furnace oil 92 per cent., and benzene 8 per cent.; or heavy tar oil 92 per cent., and benzene 8 per cent. Gas at 60° Fahr. requires 15 gallons per million cubic feet, at 70° Fahr. 25 gallons, at 80° Fahr. 40 gallons. The plant recommended is a washer in which the liquid can travel in a direction contrary to that of the gas through a series of chambers, in each of which it can be brought into intimate contact. Messrs. Young and Glover having a patent in which the principle of washing gas with oil for the extraction of naphthalene appeared to be foreshadowed, the patentees of the Burnley process are working in unison with them. Much additional useful information will be found in the paper when published.

Mr. A. F. Browne led off the discussion, criticizing several points raised by the author; but the only objection he could see to the method itself was that it required special apparatus. One mechanical objection was that, a washer being employed, the pressure on the works would be increased several inches. It appeared to him they were getting on the right track in regard to dealing with naphthalene; and his advice was "take and wash the thing out, and have done with it." The members were reminded by Mr. Thomas Glover that in 1897 he published the opinion that naphthalene was essentially a high temperature product, and that the best way to get rid of it was to wash it out of the gas. He thought the method suggested was one which would commend itself to every practical gas engineer. Mr. W. E. Price, having been advised by a tar distiller that creosote oil would probably be more suitable for removing naphthalene than green oil, as it contained less naphthalene, he tried it on a somewhat large scale. He arranged a Walker's purifying-machine so that the top tray could be filled with creosote oil. About 300 gallons of oil was required to fill the chamber; and roughly speaking, he passed 15 million cubic feet of gas through it. He withdrew the oil when he found he was obtaining naphthalene complaints; but during the time it was in use, there was a distinct reduction in the number of complaints. The quantity of oil employed worked out to twice that mentioned in the paper. He used no extra enrichment; and he did not see there was any great drop in illuminating power—certainly not more than ½ candle. Mr. C. E. Botley was in agreement with the author as to the effect of climatic changes on naphthalene; and remarked that, whatever steps were taken, condensation could not be absolutely controlled. He also gave his reasons for preferring the carburation process as applied at Hastings. In the opinion of Dr. Colman, these processes did not form the final solution of the difficulty. They were simply methods of cure. They took the naphthalene out because it was not removed in the condensers. In his opinion, the system of condensation would finally be so arranged that the whole of the naphthalene would be taken out in the condensers. Mr. Samuel Glover was of opinion that, if Mr. Price had employed an apparatus more suitable for the purpose in view, and given the gas successive washings, it would have removed the naphthalene more thoroughly. The quantity of washing oil required was dependent upon the amount of naphthalene in the gas. The washer referred to by the author was now being erected at St. Helens. Mr. C. F. Botley considered Mr. Price's experience, that creosote oil did not affect the illuminating power more than ½ candle, was extraordinary. Personally, he did not think it necessary to extract all naphthalene to prevent trouble. Mr. Lacey suggested the use of the oil-washing apparatus before the washer and scrubber; so that the naphthalene might be removed previous to the ammonia. This point the President also considered an important one; seeing that naphthalene created great difficulty on the works as well as in the distribution system. In his reply, the author mentioned that the cost of the system only amounted to a fraction of 1d. per 10,000 cubic feet, if all conditions were right. It worked perfectly satisfactorily at Burnley.

The Carbonization of Cannel and Shales for Gas-Making Purposes.

Mr. S. Glover read a carefully prepared account of the results of his studies into the question of the carbonization of cannel and shales. In carbonizing cannel, the primary object aimed at is not production of volume, but to carbonize it at such a temperature as will produce the maximum enrichment value. His investigations go to show that, by the usual method of using cannel, its full enrichment value is not obtained; the temperature at which it is carbonized is much higher than that necessary to produce the maximum yield of products capable of enriching the large volume of bituminous gases; and the condensed tars from cannels are less able to act as solvents for the naphthalene. And both these losses are still further increased during the process of condensation. But by carbonizing the cannel separately, the temperature best suited to a particular cannel used can be adjusted to produce the higher yield of enrichment; and by separately condensing the products out of the gas produced from the bituminous coal carbonized at high temperatures, the accompanying naphthalene and solvent oils are nearly all removed—not one-hundredth part of the naphthalene being left in diffusion in the gas. On bringing the gas so purified from condensable products into intimate contact with the products from the cannel carbonized at the lower temperature, the gases are free to take up their full load of carburetting hydrocarbons present in the cannel products; and the denser hydrocarbons from the cannel, being practically free from naphthalene themselves, form excellent solvents for the naphthalene still present after condensation in the large volume of

high temperature gases. The great advantage to be derived from the separate carbonization of coal to produce volume, and of cannel to produce enrichment, and the separate condensation of the high temperature gases and their subsequent contact and treatment with the cannel products, are thus fairly evident. The results the author has obtained at St. Helens throughout the last two-and-a-half years' continuous working with cannel carbonized in separate retorts and mixed as described in the paper communicated to the Institution by the author and his brother in 1898, have resulted in the enrichment of the gas (the bulk of which was made from the cheapest quality of coal) in the most economical and satisfactory manner.

Opening the discussion, Mr. Fletcher Stevenson admitted that he was so fascinated with this process when it first came out, that he tried it at the Effingham Street works at Sheffield. The details and results which he gave of the experiments made must be left until we publish our full report; but, it may be mentioned, the general outcome was that Mr. Stevenson could not see from his figures anything very special to show that the process was a success. He could not find any advantage in enrichment, because the results realized were about the average of those produced in the ordinary way. During the use of the process, the naphthalene troubles increased; but he did not attribute this to the process, as other districts supplied from the other stations were similarly affected. Mr. A. F. Browne was much disappointed that Mr. Stevenson's practical trial had not been so successful as could have been wished. Mr. Meunier's experience was that, when he carbonized coal and cannel in separate retorts, he obtained better results than by carbonizing them mixed. Mr. T. May, Mr. R. Beynon, and Mr. Foulis also joined in the discussion. The President was of opinion, from the information given by Professor Lewes and Mr. Glover, that the subject of carbonization would in the future receive far more consideration than it had done in the past. It was remarkable that Mr. Stevenson's experiments should be so absolutely at variance with those of Mr. Glover; but there was not the slightest reason why the same results should be obtained in every situation and place. Mr. Glover, in reply, said Mr. Foulis had stated that he found it necessary to employ high heats to evolve the gas from shales; but perhaps if he treated them in another way, he might get hydrocarbons which might be very useful to him in enriching the bulk of the gas to the high illuminating power which he had to supply in Glasgow. He (Mr. Glover) allowed that Mr. Stevenson had tried some "experiments;" but he did not work a sufficiently long time, nor in a satisfactory manner. The arrangement was cheaply put together; and he pointed out some of the respects which, in his opinion, had brought about the results stated by Mr. Stevenson. Mr. Meunier's experience confirmed his own, that there was something in carbonizing coal and cannel at different temperatures.

Asphalt in Tank Construction.

The next contribution was from the pen of Mr. Fletcher W. Stevenson. It gave examples of tank construction which occurred in the course of the author's work at Sheffield; but its main purpose was to show the success he achieved in rendering tanks water-tight by the use of asphalt. Two of the examples were gasholder tanks; and the third twin tar and liquor tanks. The asphalt employed was prepared from pitch containing a portion of the heavy tar oils; the distillation of the tar having been stopped at a lower temperature than is usual with tar distillers. Natural rock asphalt consists of soft limestone impregnated with bitumen; and as this soft limestone cannot be obtained for the artificial asphalt, finely ground soft chalk is mixed with the comparatively soft pitch. This, when required for use, is melted and raised to a high temperature; and a considerable proportion of fine dry sand is mixed with it. The author gives instances of the remarkable elasticity of the asphalt. The cost of the asphalt and lining to maintain it in position is, of course, more costly than clay puddle, and considerably more than cement rendering; and Mr. Stevenson does not by any means recommend its universal application. The use of the asphalt is not confined to tanks; it is equally suitable for flat roofs, wet basements of buildings, or floors on which wet processes are conducted. A few questions were put to the author; and, in his reply, he amplified some of the particulars given in the paper.

An Experiment with a Concrete and Expanded-Metal Structure.

The final paper was by Mr. A. Baker; and it described an experiment carried out at Beckton, under the instructions of Mr. G. C. Trewby, with an expanded-metal and concrete slab. The economic principles which this method of construction can undoubtedly lay claim to have been but slowly recognized by the gas profession. As the author points out, the manufacture of expanded metal is very ingenious, and consists in forming streets of trellis or net-like metal out of solid plates of iron, steel, &c., by mechanically slitting and opening out the sheets, so as to produce diamond-shaped meshes of any size and thickness. In the experiment described, the point of destruction or breaking strain was not reached owing to the foundations sinking. The expanded metal used was in sheets 17 ft. by 5 ft. 6 in. wide, 3 inch mesh, $\frac{1}{4}$ inch by $\frac{3}{16}$ inch strands. The completed structure consisted of a 6-inch slab of concrete, 17 feet clear span by 10 feet wide, supported on three jack arches spaced at 4 ft. 9 in. centres. After setting 34 days, weight was gradually applied, until the total evenly distributed over the whole structure was 128 tons 5 cwt., equal to 15·09 cwt. per square foot. The slab was carefully examined at this stage, and found quite intact, with a deflection in the centre of $\frac{1}{2}$ inch. Expanded metal has been used in many of the new buildings at Beckton for some time now, with satisfactory results. The paper did not lend itself to discussion. But Mr. Herring stated that he had arranged for a similarly constructed floor in a purifier-house, and had used expanded metal in connection with the concrete bottom of a gasholder tank. The President also mentioned that he had given instructions for the construction of an overhead revivifying-floor on this principle.

The Autumn Meeting and the International Conference in Paris.

The last matters of importance upon which the President invited the members to express their opinions were the holding of an autumn meeting, and the acceptance of the invitation of the Société Technique to attend the International Conference to be held in Paris in September in connection with the Gas Section of the Exhibition. The projected union with the Gas Institute rather complicated the matter; but the members got over the difficulty for the time in the easiest manner possible—first, by endorsing the action of the Council in accepting the invitation of the Société Technique, and, secondly, by authorizing them, if a sufficient number of members signify their intention of attending, to hold a meeting in Paris in the autumn.

A few votes of thanks terminated a meeting which, for the uniform quality of the proceedings and the sustained interest of the members, has, it is not too much to say, never been exceeded in the history of the Institution.

On Thursday, the members and a few friends paid a visit to the Woolwich Arsenal, where they were privileged to view several of the departments not usually opened to the public. Lunch was served at the Royal Mortar Hotel; and, in the afternoon, brakes conveyed the party to the Crystal Palace, where in the evening they dined together. Unfortunately, there was a break in the beautiful weather of the two previous days; and this slightly disturbed the happiness of the occasion.

GENERAL REPORT.

The General Meeting of the Institution was held last Tuesday and Wednesday, in the Hall of the Institution of Civil Engineers, Great George Street, Westminster.

Mr. F. D. Marshall (Copenhagen), the Retiring President, occupied the chair at the commencement of the proceedings.

Annual Report and Accounts.

The Chairman opened the business by moving that the annual report and statement of accounts, which had been circulated among the members (see *ante*, p. 998), be received and adopted.

Mr. T. May (Richmond) seconded the motion; and it was carried unanimously.

Additions to the Roll.

The following list of new members and associates, who had been unanimously elected, was then read :—

MEMBERS.

Anderson, Eugene E. J., Gas-Works, Ripon.
Morland, W. S., Gas-Works, Hempstead, Gloucester.
Richmond, Christopher, Gas-Works, Nechells, Birmingham.
Rutter, C. H., Gas-Works, Mill Hill, N.W.

ASSOCIATES.

Franks, C. F., Bankside.
Green, B. R., Mitcham.
Kindler, H. K., Maidstone.
Paterson, J., Gloucester.
Pettigrew, W. E., Leeds.
Sharp, M. H., Bexhill.
West, C. B., Vauxhall.

The New President.

The Chairman said it only remained for him to thank the members for the kind support they had all given him during his year of office, and to express the hope that if he had left undone any things which he ought to have done, or done things which he ought not to have done, he would be forgiven. He had now simply to introduce his successor, Mr. Helps, which he did with very great pleasure, and in the hope that he would be as cordially received as he (Mr. Marshall) had been himself.

Mr. James W. Helps, M.Inst.C.E. (Croydon), then took the chair.

Thanks to the Past-President.

Mr. W. Foulis (Glasgow) moved a hearty vote of thanks to Mr. Marshall for the admirable way in which he had conducted the business of the Institution during his year of office. They all, he said, remembered the way he presided over the meeting last year, and especially the pleasant trip in the autumn, the great success of which was entirely due to the exertions of Mr. Marshall.

Mr. T. S. Lacey (Pimlico) seconded the motion with much pleasure ; and it was carried with acclamation.

President's Address.

The President then read his Inaugural Address, which was given in the "Journal" last week (pp. 1109-1114).

Mr. F. W. Stevenson (London) said the address was a most instructive one, bristling with points of interest ; and it would be read very carefully when published. He had not known the President for so many years as some of the members had, but for two or three he had enjoyed an intimate acquaintance with him ; and he felt, when he was proposed as President, that no better man could have been selected, and that the prestige of the Institution would be maintained, if not enhanced, in his hands. Whatever difficulties might lie before them in the coming year, he was quite sure the President would guide them safely through them ; and he (Mr. Stevenson) had great pleasure in moving that the best thanks of the meeting be given to him for his address.

Mr. W. R. Herring (Edinburgh) expressed his pleasure in seconding the motion, which was carried unanimously.

The Proposed Amalgamation.

The President, having acknowledged the vote of thanks, said the next business before the meeting—and it was a matter of very great importance—was the question of the suggested amalgamation with the Gas Institute. Before asking for any expression of opinion on the subject, it might be well for him to give some slight outline of the reasons which prompted the Council to take action in this matter. If there were any present who thought the Council had gone too far, he trusted he might be able to show that they had not in any way pledged either themselves or the members to any special course of action. It came to their knowledge, early last November, that the governing body of the Gas Institute were prepared to discuss the question of amalgamation, and he, as President, was requested to seek an interview with the President of the Gas Institute, and ascertain his views. This he did; and he also met the Honorary Secretary. On talking over matters, he was pleased to find that there apparently existed no reason why an amalgamation should not be brought about. He reported on the matter in a letter which was considered at a meeting of the Council, to which all former members and Past-Presidents were invited, so that it was a very representative gathering. The subject was carefully discussed, and a resolution was proposed (a copy of which was sent to the President of the Gas Institute) that, in the opinion of the Institution of Gas Engineers, provided that satisfactory rules governing the qualification of membership were drawn up, reunion or amalgamation was advisable. The Gas Institute adopted a similar course; and a Joint Committee was formed, which met on several occasions, and drew up the set of rules which had been distributed among the members. And it now only rested with them to say whether they approved the action of the Council so far. It was not proposed on this occasion to pass any special resolution pledging themselves to dissolution, which was practically a *sine quâ non* to amalgamation. According to the rules of both Associations, it was impossible to deal with the funds of either except in one way. Any funds remaining, after paying all working expenses, were to be handed over to some Institution having similar aims and objects. It was therefore necessary that some Institution should be formed before the present ones were formally dissolved. It was therefore proposed that day to submit a resolution simply pledging themselves to the general principle that it was advisable, under certain conditions, that steps should be taken to bring about an amalgamation. The course which would then have to be taken was this: They would first have to call a special meeting to be held immediately after the meeting of the Gas Institute in June (providing that at that meeting the members of the Institute showed themselves willing and anxious to meet them in the matter), at which a resolution would be passed pledging themselves to dissolve. Meanwhile, steps would have to be taken for the formation of a new Institute. Not less than fourteen days, and not more than a month, afterwards it would be necessary to hold a confirmatory meeting (probably the two Institutions would hold such meetings at about the same time), when the resolution need only be carried by a bare majority. In the first place it would have to be carried by two-thirds of those present. Assuming that the meeting to-day decided that the scheme as proposed by the Council was the right thing, and that the Gas Institute did nothing to alter the circumstances, it would be a matter of course for the whole project to go through at the special meeting to be called in June. It only remained for him now to ask the members to express their opinions on this very important subject ; and he would ask them to do so with the welfare of the gas industry principally in mind—putting aside any personal motives.

Mr. George Livesey said, as he was one of the chief "delinquents" in causing the disruption, it might be appropriate that he should commence the discussion. It had been one of the great objects of his desire for many years to see the gas industry thoroughly united. Happily those who were separated into two distinct organizations still retained their old friendships. He thought it was due to one gentleman not present that he should say a word with reference to the possibility of reunion. He was informed some time ago by their old friend Mr. Sellers, that Mr. Bray would be quite ready to shake hands. Of course, as soon as he heard this he told him that he (Mr. Livesey) should be ready too. Letters passed between them; and he must say that Mr. Bray, whom he had always regarded as an honest man, met him in a most honourable and fair manner. Not only that, but he went to the last meeting of the Gas Institute and told them that it was for them to command and for him to obey; and, in the most handsome manner, he removed all possibility of difficulty on his part—in fact he (Mr. Livesey) believed him to have been an honest man all through. He did not know that he need say much more about the matter, except to give this movement his most hearty approval. He had read the rules suggested, and he must say he considered they were most complete and comprehensive. There was only one point which he thought could be improved, and that was that there might be some provision for enlisting the pecuniary support, at any rate, of gas undertakings—corporations and gas companies themselves. As far as he could see at present, the funds were to be provided entirely by the members. He had put a query against the annual subscription of two guineas. This, however, was a mere matter of detail; but he thought it would be advisable to have some means of obtaining the pecuniary support of gas undertakings. He had received a letter the previous day from Mr. Cripps,

in which he put forward some very good ideas. His proposal was that the new Gas Institute, or whatever it was to be called, should be the leading technical representative of the gas industry throughout the world. He (Mr. Livesey) heartily agreed with that; and he could only express the hope that the labours of the President and Council, and that of the sister Association, might result in something of the sort. It was very necessary that they should be united, especially at the present time, when the difficulties which surrounded the gas industry were greater than ever. Thirty years ago, they had an absolute monopoly of lighting. Now they were met by the fiercest competition; and above all things it was necessary to present a united front, so as to maintain intact the great industry in which they were engaged, and not only that, but to see that it progressed with the times, and served the wants of the whole community better than it had ever done before.

Mr. W. FOULIS (Glasgow) said he well remembered the separation of the two Associations, and what led up to it, for he believed he was President that year; and he considered Mr. Livesey had perhaps taken too much blame to himself when he said he was the greatest "delinquent." He believed that what led to the rupture was simply an incident. It had really nothing to do with the feeling which they all had as to the particular circumstances in which the Institute was placed. He had full sympathy with the two Associations joining, and thought the rules which had been drawn up by the Joint Committee were admirable. As far as he could see, they were rules under which an amalgamation might be effected with satisfaction to both bodies. One thing, however, should be perfectly understood—that, while they were prepared to amalgamate under these rules, there must be no attempt to go beyond that which might alter the whole condition of things.

Mr. T. P. BALL (Rochdale) thought, in the event of the discussion proving favourable to the abstract principle, the Council would submit a resolution to the meeting. He took it that they were not then going to discuss the draft rules which had been submitted, but to confine themselves exclusively to the question of amalgamation, assuming that the terms suggested were those on which it should be carried out.

The PRESIDENT remarked that, at the same time, if anybody objected to the rules, or had an improvement in them to suggest, it would be well to make it. The whole question was open for discussion.

Mr. BALL said, so far as they were concerned, he took it that any material alteration of the rules by the Gas Institute would leave them perfectly free to rescind any resolution passed that morning in favour of amalgamation. He thought they were all agreed that, in the abstract, amalgamation was desirable. They all retained their old friendship for members of the other Association; and he thought, with the rules as now drafted, such unhappy incidents as occurred previously would be practically impossible. Personally, he could see no objection to them; and he congratulated those who had drafted them on the success of their efforts. He should be happy to see the time when, under such rules, the members of the gas profession were all united in one body.

Mr. CHARLES HUNT (Birmingham) said he agreed with the previous speakers, and thought their thanks were due to the President and those who had co-operated with him in bringing forward a scheme which promised so well, though there were one or two slight matters to which he should like to draw attention. With regard to the last clause, providing for the formation of Local Sections, he should like to suggest that it might be desirable to provide for the representation of the Sections by the admission to the Council of the Chairmen and Secretaries. Then as to the name. It had been suggested that the name should be "The Institution of Gas Engineers and Managers." He quite understood the object of this; but, without any liking for the present name simply because it was the existing one, he thought it was preferable—either that or "The Gas Institute." The objection he should urge to the name "The Gas Institute" was that it implied a somewhat heterogeneous, and not a homogeneous, assembly such as they should hope to have hereafter. He belonged to the Iron and Steel Institute, which in that case seemed a perfectly appropriate name. The members were not all steel makers or iron makers; they consisted of anybody who had the remotest connection with iron, steel, or even coal. But in their particular case they had one object; and therefore he thought "Institution" would be the proper name.

Mr. R. BEYNON (Torquay) said he was entirely favourable to the scheme; but he should like to know whether it would have any effect on the Gas Companies' Protection Association—whether it was intended that the new Institution should take up the duties of that Association as well.

Mr. LIVESEY said there was a difficulty about the duties of the Gas Companies' Protection Association being taken up by the Gas Institute or the Institution of Gas Engineers, because the Association was simply for the protection of Gas Companies; whereas the gas industry included almost an equal number of Corporations who were not members of the Association at all. When the Association was being formed, there were some members who expressed themselves rather strongly on this point—that if corporations were to be admitted to membership, they would not join. Unfortunately, Corporations and Gas Companies were too often in the position of antagonists—he did not say Corporations supplying gas, but those in towns where Gas Companies existed were very often in antagonism to them; and the Gas Companies' Protection Association might often have to oppose Corporations. He should like to see the whole thing all in one; but he was afraid this could not very well be.

The PRESIDENT then moved the following resolution: "That the members of the Institution of Gas Engineers, having considered the question of an amalgamation being brought about with the Gas Institute, are of opinion that it would be to the best interests of the gas industry that such a course should be adopted; and they therefore wish to express their approval of the action of the Council in the matter, and their desire that the necessary steps should be taken to carry out the proposed scheme."

Mr. S. Y. SHOUBRIDGE (Lower Sydenham) asked whether the small class of members, the associate members and extraordinary members, had been consulted in this matter, and had signified their approval.

The PRESIDENT said the Institution had only one honorary member—Baron Auer von Welsbach.

Mr. SHOUBRIDGE remarked that the Gas Institute had a large number.

The PRESIDENT said he could not attempt any explanation with regard to the Gas Institute.

Mr. BALL remarked that there was no reference in the resolution to the conditions under which the amalgamation should take place.

The PRESIDENT said he should take it, that, if they expressed approval of the action of the Council, it practically included the suggested rules.

Mr. FOULIS thought they would all agree to amalgate on these terms; but this should be made quite plain.

Mr. LIVESEY pointed out that it was very common, when a Company were going to Parliament, to pass a resolution that the meeting approved of the Bill, subject to such alterations as Parliament might insist upon and the Directors might agree to. He said they did not want to bind themselves absolutely to the rules submitted, but only to the principle.

Mr. FOULIS said the rules were not drawn up by them alone, but by a combined Committee of the two Associations. These were the rules submitted, and these were the conditions under which the Institution were willing to amalgamate. But they could not bind themselves to say they would amalgamate under any altered rules.

Mr. R. MORTON (London) said they could not bind the Council not to interfere in the slightest degree with these rules. As one of the original members of the British Association of Gas Managers, he felt very keenly the disruption which took place some years ago; and he was very glad now to think there was a probability of there being a fusion of the two bodies.

The PRESIDENT thereupon read the following amended resolution: "That the members of the Institution of Gas Engineers, having considered the question of an amalgamation being brought about with the Gas Institute, are of opinion that it would be to the best interests of the gas industry that such a course should be adopted. They therefore wish to express their approval of the action of the Council, and of the rules drawn up by the Joint Committee; and they desire that the necessary steps should be

taken to carry out the proposed scheme, in accordance with the principles of the draft rules submitted to the meeting."

Mr. F. W. STEVENSON (London) seconded the resolution. He said he had felt all along that the time would come when the two Associations would be amalgamated. It did not seem right that the gas industry should have two Associations; and now, as they all seemed to be of the same opinion, it would be a great pity if any hitch should occur. He believed the resolution would meet the feelings of the Council and of the members.

Mr. W. R. COOPER (Banbury), as one of the older members, greatly sympathized with any step which could be taken to bring the two bodies together; but he could not quite endorse the remarks of Mr. Foulis, when he said they must not in the slightest degree depart from the rules drawn up. The members of the Gas Institute were very different from their own members; and he was afraid that, if the rules as now submitted were to be held to as a cast-iron set of rules, they would not pass that body. He should therefore like it to be understood that they were holding out the olive-branch to the other Institute, and would do all they possibly could to meet them, and bring about a spirit of conciliation between the two, so that old friendships might be renewed, and that they might work harmoniously as one body, and become, as Mr. Livesey had said, the finest Gas Institution in the world.

The PRESIDENT said he quite appreciated the remarks of the last speaker; but he thought the resolution, as now worded, would allow the Gas Institute to make certain alterations without departing from the principle embodied in the draft rules.

The resolution was then put and carried unanimously.

READING OF PAPERS.

The reading of papers was then commenced. They were taken in the following order :—

Tuesday.—(1) "The Enrichment of Coal Gas." By GEORGE LIVESEY. (2) "The Calorific Power of Illuminating Gas." By HAROLD G. COLMAN. (3) "Inclined Retorts at Bankside." By C. C. CARPENTER.

Wednesday.—(4) "Water Gas and its Recent Continental Developments." A Lecture by VIVIAN B. LEWES, F.I.C., F.C.S. (5) "The Presence of Naphthalene in Coal Gas: Its Detection and Extraction." By WILFRED IRWIN. (6) "Notes on the Carbonization of Cannel and Shales for Gas-Making Purposes." By SAMUEL GLOVER. (7) "Some Examples of Tank Construction." By FLETCHER W. STEVENSON. (8) "An Experiment with a Concrete and Expanded-Metal Structure." By A. BAKER.

The papers by Mr. Livesey and Dr. Colman, with the discussions thereon, and the lecture by Professor Lewes, will be found in another part of the "JOURNAL." The rest will be given next week.

At the close of the discussions on Wednesday afternoon, the general business was resumed.

APPOINTMENT OF SCRUTINEERS.

The PRESIDENT said the Scrutineers last year were Mr. A. E. Broadberry, Mr. H. Iago, and Mr. W. E. Price; and he would propose that these gentlemen be re-elected.

The proposition was carried unanimously.

THE AUTUMN MEETING AND THE PARIS CONFERENCE.

The PRESIDENT said he had now to bring forward a matter which was of some importance—that of the autumn meeting. The question whether they should have such a meeting was somewhat complicated by the uncertainty which must naturally exist as to whether, when the time for it came, there would be such an Institution in existence as that of the Gas Engineers. From the unanimous manner in which the resolution had been passed on the previous day, he gathered that they all hoped there would be no such Institution. Still they must provide for the future. The question also raised a point of more importance than perhaps some might think—one of almost international importance. As most of them were aware, the Institution received some time ago an invitation from the gas authorities in France to attend and join in an International Conference to be held in September next in connection with the Paris Exhibition. A great many different opinions had been expressed, both in private and in public, as to whether Englishmen ought to go to Paris. The matter had engaged the very serious attention of the Council on more than one occasion; but it had been decided that they should formally accept the invitation of M. Vautier, the President of the Société Technique du Gaz, and he should like to hear from the members whether or not they approved of the action of the Council in this matter. It was useless to disguise the fact that great diversity of opinion existed in consequence of the action of a certain section of the Press in France in connection with political affairs and the war in South Africa. Personally, he did not agree with those who desired to gauge the character of the French people by the vapourings of the lower section of the Press, because he thought Englishmen would be very sorry to have their characters gauged by certain papers which they might see on the bookstalls any day, but which they certainly did not read, and took no more notice of than the better section of the French did of the wretched prints to which he had referred. There was some reason, no doubt, for the fact that Englishmen just at present were not in very good odour on the Continent, because the feeling was not confined to France. Almost everywhere there was a very great *consensus* of opinion on the question of the South African war. It was not for him to discuss this question; but he did think that in all matters connected with science, literature, or their own immediate industry, no attention should be paid to what had been said by some sections of the foreign Press. He should like the meeting to express an opinion that they would do all they could, by their presence and otherwise, to help to bring to a successful issue the International Conference in connection with the gas industry at the Paris Exhibition. The Institution had been invited; but it would be quite impossible for them all, as a body, to accept the invitation. There would be certain functions, no doubt, which would have to be attended, and a certain amount of hospitality would be offered; and therefore it would be necessary to dissever the two matters—the autumn meeting and the acceptance of the invitation by the French authorities. The members might decide to hold an autumn meeting in Paris; but it should be thoroughly understood that any acceptance of the invitation from the French Society would be simply confined to a deputation to be appointed in some way by the Council. He believed that other engineering and kindred Associations had adopted this principle of appointing a deputation to represent their particular industries; and no doubt this would be the case with the Institution. He would ask the members, therefore, first to express their opinion on the subject of an autumn meeting; and then he trusted they would be able to pass a unanimous vote in favour of the acceptance of the invitation of the Société Technique to the International Conference. He might add that the authorities in France were very anxious, among other things, to obtain photographs of gas-works in England; and if any gentlemen had views of their works, he should be obliged if they would send copies to M. Lebon, who was collecting them. The Council had appointed two corresponding members, of whom he was one and Mr. Marshall the other; and he found that among their duties they had either to prepare for, or read at, the conference a paper which it was preferred should be in French. He was afraid that neither Mr. Marshall nor himself was prepared to do this; but he had a letter from M. Vautier saying that they might get substitutes. If there was a member who had a subject which he could deal with in such a manner as to reflect credit upon the industry, he (the President) would be very glad if he would undertake to prepare and read it. It would be accepted in English, although it would be preferred in French. He regretted that Mr. Marshall was not present, because he knew he felt very strongly on this subject; and he had spoken lately with several people in high positions in England, who felt that they would be doing an injustice to themselves and to the country if they did anything which would militate against the success of the conference.

Mr. C. GANDON said that, from some knowledge of the Continent, he felt sure that, whatever was done by a certain section of the Press would not have any influence on the visit of the Institution. He was sorry to see that any suggestion should be made that, on account of what some people called the "gutter" Press, not only the Institution but Englishmen generally should abstain from visiting the Paris Exhibition. He thought this was a most

erroneous idea; and he felt quite certain that anyone who visited Paris would meet with a cordial reception. It occurred to him that scientific societies had no business to mix themselves up in politics. He should strongly support an autumn visit to Paris, and the acceptance of the invitation which had been received.

Mr. W. KING (Liverpool) quite agreed with the remarks of the President and Mr. Gandon that it would be very wrong to judge of their scientific French brethren from the outpourings of the vilest portion of the French Press. It was a matter which ought not to be discussed any longer. With regard to the other point, personally he had always received such kind hospitality from those connected with the Paris Gas Company, that he should look forward with great pleasure to a visit to the city. He did not think they could do better than abandon the idea of an autumn meeting, but either individually or collectively take part in this International Gas Congress which might be substituted for the autumn gathering. He hoped the Council would take steps to see that the Institution were represented and took part in the congress, which must be calculated to increase the good feeling between gas engineers of all nations.

Mr. C. E. BOTLEY (Hastings) said he was perfectly certain that whoever might be appointed to represent the Institution in France or Germany would be received with the greatest courtesy and hospitality. They ought not to mix themselves up with the attacks which had been made on the Queen or the Government by the "gutter" Press, but should follow the example of the Prince of Wales, who, he saw, had expressed his intention of going to Paris.

The PRESIDENT then moved the following resolution: "That this meeting endorses the action of the Council in accepting the invitation of the Société Technique du Gaz to attend the International Conference to be held in Paris in connection with the French Exhibition."

Mr. GANDON seconded the motion; and it was carried unanimously

The PRESIDENT said the next question was whether or not they should hold an autumn meeting.

Mr. BOTLEY suggested this should be left in the hands of the Council.

Mr. W. E. PRICE (Hampton Wick) supported the suggestion.

Mr. T. B. BALL (Rochdale) remarked that this would leave the matter in a state of uncertainty up to almost the last moment.

The PRESIDENT said the question seemed to be whether they should definitely decide to have an autumn meeting, and leave the arrangements in the hands of the Council, or leave with them the whole decision whether or not to have an autumn meeting.

Mr. T. MAY (Richmond) thought the latter question had better be decided now.

Mr. W. R. HERRING (Edinburgh) suggested that as the Gas Institute would be holding their meeting next month, the matter should be left in the hands of the Council to come to a decision before the end of June. In the event of an amalgamation of the two bodies taking place, it would probably be necessary to make arrangements for all the members visiting Paris at the same time, even though they might not be a united Institution by then.

The PRESIDENT said he believed the Gas Institute were going to take their excursion to Paris at the end of the June meeting.

Mr. HERRING said he understood there was some doubt about that. Possibly they might delay it a little.

The PRESIDENT said he thought Mr. Ball's suggestion was the best—that the matter should be left in the hands of the Council, with the understanding that, if there were an autumn meeting, it should be held in Paris some time during September.

Mr. BOTLEY said he would agree to this.

The resolution, in this form, was put and carried.

VOTES OF THANKS.

The PRESIDENT then proposed that the best thanks of the meeting be given to the President and Council of the Institution of Civil Engineers for their kindness in granting the use of the rooms of the Institution for the purpose of the meeting.

This was seconded by Mr. GLOVER, and carried.

The PRESIDENT then moved that the best thanks of the meeting be accorded to the authors of the papers, which this year had, he said, been an extremely good set, and had given rise to very useful discussions.

Mr. C. F. BOTLEY seconded the motion, and it was carried unanimously.

The services of the Honorary Auditor (Mr. Magnus Ohren) having been acknowledged,

Mr. G. P. LEWIS proposed a vote of thanks to the Council for their management of the affairs of the Institution in the past year.

Mr. GLOVER seconded the proposition; and it was unanimously agreed to.

Mr. BALL moved that the best thanks of the meeting be given to the President for his conduct in the chair.

Mr. GLOVER seconded the motion; and it was carried unanimously.

The PRESIDENT having expressed his heartfelt thanks for this renewed mark of confidence on the part of the members, and for the kind manner in which they had supported him during the past year, moved a vote of thanks to the Secretary (Mr. Thomas Cole).

The compliment having been suitably acknowledged by Mr. COLE, the proceedings closed.

THE LECTURE.

WATER GAS AND ITS RECENT CONTINENTAL DEVELOPMENTS.

By VIVIAN B. LEWES, F.I.C., F.C.S.

Your President has honoured me by asking me to bring before you the details of the Dellwik-Fleischer process, which has practically revolutionized the use of water gas on the Continent for industrial purposes, and which is now playing an important part in several Continental gas-works. It was at the Bath meeting of the Gas Institute, in 1897, that I introduced the new-born babe to the notice of the English gas industry; and since then I have watched its early steps with increasing interest. The time having now arrived when all doubt with regard to it has been dispelled, I gladly accept the opportunity of detailing to you the most recent developments in Continental gas making practice, and the part which water gas is playing in regard to it.

I do not wish to weary you with an historical essay on the growth of water gas from Fontana's memorable experiment in 1770 to the present time; but I must ask you to bear with me while I go into the details of the European water-gas practice during the past fifteen years, in order to make clear to you the important developments the last decade has brought forth, and why it is that water gas now occupies a far different position to that which it did ten years ago.

Water gas, which is the name given to the mixture of gaseous products obtained by decomposing steam by incandescent carbon, consists of hydrogen and carbon monoxide as its main constituents, with traces of carbon dioxide, methane, and nitrogen as its impurities; and the early attempts to make it on a large scale all consisted of retort processes, in which charcoal or coke was heated to the highest attainable temperature while steam was passed through the incandescent mass.

The amount of heat, however, absorbed by the decomposition of the water so far exceeded the temperature generated by the formation of the carbon monoxide, that the exterior heat was seldom sufficient to keep the mass at a bright red heat, and the temperature of the fuel always rapidly fell; and as it was reduced, so the quantity of carbon dioxide in the gaseous mixture increased—the result being that no continuous retort process has up to the present time proved successful. It was only when Gillard, in 1849, first introduced the idea of blowing up the carbon to incandescence by means of an air blast, and then steaming the incandescent fuel to form water gas until the temperature fell to the point at which carbon dioxide began to appear, that any successful issue seemed probable in forming a completely combustible gaseous fuel from the solid carbon. After many vicissitudes in Europe and America, several Continental works, during the eighties, set up generators upon this principle of "blow and run." Perhaps the most successful form of generator was that adopted by Messrs. Schultz, Knaudt, and Co., at Essen, who employed the gas for

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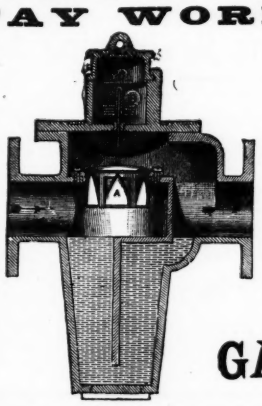

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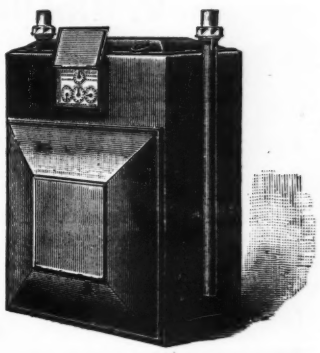

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welding tubular boilers, and for lighting by means of the Fahnehjelm incandescent combs.

The form of apparatus installed by them, and which is still in use, consisted of what is practically a cupola furnace lined with firebrick, and with a constriction a short distance above the hearth; the firebrick being protected at this point by a water-cooled ring. The usual size of the generator was about 20 feet in height and 7 feet in diameter. The air blast was admitted below the water-cooled ring; and by "blowing" for about 10 minutes the ignited fuel was raised to incandescence, when the air blast was cut off and steam admitted above the top of the fuel. This, passing down through it, was converted into water gas, which escaped by the same opening through which the air blast was admitted; the inlet and outlet being opened and closed by means of a water-cooled valve slide of such construction that it was impossible for any explosive mixture of water gas and air to be formed.

This process was introduced in 1887-8 at the Leeds Forge, where, as at Essen, it was used for welding purposes; and also, to a limited extent, in the manufacture of steel by the Siemens-Martin process. In these installations, the fuel is first raised to incandescence by an air blast, which causes the combustion of a portion of the fuel and yields as a gaseous product the so-called "producer gas," which has the average composition—

	Per Cent.
Nitrogen	63·64
Carbon monoxide	29·33
Carbon dioxide	4·15
Hydrogen	2·88
	100·00

and which, although it only contains 32 per cent. of combustible matter, can be used as a fuel gas, provided it is burnt while still hot. In order to ensure the temperature of the fuel being raised sufficiently high for the production of 1000 cubic feet of water gas, the air blast has to be used for such a lengthened period that no less than 4000 cubic feet of producer gas is formed, which requires the combustion of over 44 lbs. of carbon from the fuel; and as the 1000 cubic feet of water gas contain about 15 lbs. of carbon, it will be seen that each 1000 cubic feet of water gas means the consumption of about 60 lbs. of carbon. These data have been calculated from analyses of the producer and water gas; but they have proved correct in practice. If the percentage of carbon in the coke used be taken in pounds per ton and divided by 60, the resulting figures will approximate very closely to the actual yield of water gas obtained from the particular quality of coke by the old process.

The average yield of water gas per ton of coke may be taken as 34,000 cubic feet; and although some observers have given lower figures, the quality of the coke must be taken into consideration. For instance, with a dirty and crumbly coke a longer blow is required, which, of course, means increased consumption of fuel.

A thousand cubic feet of water gas contain as the combustible constituents hydrogen, 2·75 lbs.; carbon monoxide, 30·00 lbs. The thermal value will be represented by—

$$(2{\cdot}75 \times 34{,}400) + (30 \times 2400) = 155{,}600 \text{ units};$$

while the thermal value of the 60 lbs. of coke used would be—

$$8080 \times 60 \doteq 484{,}800 \text{ units.}$$

So that the thermal value of the water gas is only 34 per cent. of that of the carbon from which it was formed; and it is this loss which has proved so great a drawback to the economic utilization of the gas.

If, however, the producer gas can be utilized while it is hot, another 223,328 thermal units will be obtained; bringing the total calorific value of the two mixtures to 80 per cent. of the value of the carbon consumed in their formation. If this could have been carried out in practice, water gas would have no doubt proved successful. But when one considers that the processes of making producer and water gas are intermittent, and that four times the volume of producer gas is obtained as of water gas, it is evident that these drawbacks are difficult to overcome, as the producer gas would have required enormous storage space, and, after cooling down, is hardly worth burning.

When the present process for the manufacture of carburetted water gas was introduced, it became at once apparent that the producer gas—the loss of which had crippled all previous water-gas processes—could be utilized for raising chambers filled with chequer brickwork to a high temperature, in order to decompose the oils, to yield the oil gas which, mixed with the water gas, rendered the latter luminous; and it was in this way—by making the carburetted water-gas plant a perfect heat-machine—that its great success was achieved. In raising the fuel to incandescence, the producer gas, with all its heat in it, was at once burnt with a fresh supply of air in the superheating chambers; the practical loss of heat taking place throughout the whole apparatus being reduced to a minimum.

In 1896, Mr. Carl Dellwik introduced a modification in the process of making water gas, which entirely altered the whole aspect of the industry. In all the attempts to make water gas which had seen the light up to that date, the incandescence of the fuel has always been obtained by "blowing" so deep a bed of fuel that carbon monoxide and the residual nitrogen of the air formed the chief products; and it must be remembered that in the formation of carbon monoxide in producer gas, only 2400 heat units are developed per pound of carbon, but if sufficient air be present to burn the carbon to carbon dioxide, 8080 heat units are obtained—an amount which is 3·37 times as great. This is the principle upon which Dellwik devised his process, the main point of which is the adjustment of the air supply to the fuel in the generator in such a way that carbon dioxide is formed instead of carbon monoxide.

Under these conditions, the producer gas ceases to exist as a bye-product, and the products of the blow consist merely of the incombustible products of complete combustion—carbon dioxide and nitrogen; the result being that more than three times the heat is developed for the combustion of the same amount of fuel, and double the quantity of water gas can be made per pound of fuel than was before possible, and the runs or times of steaming can be continued for longer periods. In the old "European" process, it was necessary to blow for nearly ten minutes in order to bring the fuel to the correct temperature; while the period of steaming only lasted for from four to five minutes. But in the Dellwik process, the blow rarely exceeds two minutes; and it is possible to steam for from seven to ten minutes.

At first sight, it would appear that this plan must result in the formation of a considerable amount of carbon dioxide; but an examination of the gas soon corrects this idea, as is shown by analyses of samples taken at intervals during a run.

	I.	II.	III.
Hydrogen	52·43	50·09	52·76
Carbon monoxide	38·30	39·95	37·50
Carbon dioxide	4·73	5·38	4·08
Oxygen	0·74	1·22	0·46
Nitrogen	3·80	3·36	5·20

and as 5 per cent. of carbon dioxide in the unpurified gas may be looked upon as a fair average when using the old "European" process, these results are distinctly good. In order to make sure that no mistake was being made, analyses were taken during a long series of runs, and also from the gas in the holder, when it was found that the average came out at 4·58 per cent.; the highest being 4·9 per cent., and the lowest 4·2 per cent.

The Dellwik process has come at a moment when the general views as to the actions taking place during the combustion of carbon are undergoing a radical change; and no better example could be found to illustrate these views than the cycle of operations taking place in the generator during the two processes of blowing and steaming. The old theory is that when carbon is burned carbon dioxide is formed, and this carbon dioxide, in contact with more incandescent carbon, becomes reduced to double its volume of carbon monoxide. All such theory is now changed; and the work of Dixon, Baker, and others shows us that the direct combustion of carbon with oxygen yields only one oxide (carbon monoxide), and that this is the primary product of combustion, while this carbon monoxide, in contact with oxygen or any oxidizing substance, forms carbon dioxide.

Working under the old theory, a deep bed of fuel was taken in the generator, and the air current was driven into it; and it was considered that the dioxide was formed at the bottom of the generator, where the air was in excess, and that as the oxygen was used, so this became reduced to carbon monoxide, which was found in the producer gas in the upper portion of the layer. However, at the present time we know that, as long as there is no air in excess, carbon monoxide can be the only product of the action; and in all the old generators, a large excess of carbon as compared to the air being present, the temperature which could be produced was merely the temperature of the formation of carbon monoxide.

In the Dellwik plant, however, the conditions are reversed; and by lowering the height of the bed of fuel, keeping it at a constant level, and increasing the pressure under which the blast is driven through the heated coke, the air is kept always in excess, so that as carbon monoxide is formed by the primary combustion of the carbon, there is always sufficient oxygen present to oxidize the carbon monoxide to dioxide, and the total heating effect is increased more than threefold for the same combustion of carbon. In this lies one of the great secrets of the Dellwik process, as the fuel burnt for the same increment of temperature is less than a third of that used in the old process.

In the same way our ideas as to the chemical actions taking place during the formation of the water gas, as the steam passes over the incandescent fuel during a run, need modification. The formation of carbon dioxide in the water gas has always been explained by the assumption that there is a variation in the actions which take place according to the temperature of the fuel, and that at high temperatures the decomposition of the steam may be represented as :—

Steam. Carbon. Carbon Monoxide. Hydrogen.

$$H_2O + C = CO + H_2$$

while as the temperature of the fuel bed falls, the action approximates more and more closely to—

Carbon Dioxide. Hydrogen.

$$2H_2O + C = CO_2 + 2H_2$$

This view is, however, incorrect, and the carbon dioxide is not formed by the action of steam directly on carbon at all, but by the oxidation of the carbon monoxide first formed, and the actions should be represented by the equations—

$$(1)\ H_2O + C = CO + H_2$$
$$(2)\ H_2 + CO = CO_2 + H_2$$

Carbon monoxide begins to decompose steam, with conversion into carbon dioxide and liberation of hydrogen, at a temperature of 625° C.; so that at any temperature above this point, and below the temperature at which carbon dioxide dissociates, you always produce dioxide if an excess of steam is used, while at any temperature above that at which carbon decomposes steam, carbon monoxide only is formed, as long as no excess of steam is present.

The result of all this is that if as the temperature falls and the area of carbon sufficiently heated to decompose the steam becomes less and less, we reduce the inlet of steam in a slightly greater ratio, it is possible to make water gas from end to end of the run without any carbon dioxide at all—the only secret being that no excess of steam shall be present at any period of the operation. The result of the beautiful welding of theory and practice in this form of generator, gives us the power of producing 70,000 cubic feet of water gas per ton of carbon, as against 34,000 cubic feet with the old process; and, in consequence, a most important cheapening in the manufacture of the gas is achieved, and water gas is now the most important factor for economically obtaining high temperatures that the world possesses.

Leaving, now, the theory and practice of the water-gas generator, let us turn to the way in which the Dellwik process has been utilized on the Continent as an adjunct in coal-gas manufacture. In Germany, the duty on carburetting oils, and their consequent high price, has rendered the beautiful carburetted water-gas processes which have been so largely employed in England, practically impossible; and here we are now face to face with much the same kind of trouble. Owing to various causes, carburetting oil has increased in price to a pitch which threatens to make its commercial utility as an enricher practically *nil*. But, luckily for the gas manager, he is not bound down to any one process of enrichment; and when increased consumption or supposed security on the part of financial operators have led to an undue increase in price in one enricher, he can flit to another form of enrichment until the balance of supply and demand has once more had time to right itself. Cannel enrichment went up until carburetted water gas came in. Now, in turn, carburetting oils have all of them risen and we are beginning to look round to see what will enter by the door so opened.

During the past fifteen years, the gas manager has been lamenting the falling off in his profits, due to the rapid decrease in the price of benzol, which has been brought about by the large quantities produced in the coke-ovens which, in the old days, used to be burnt to waste, but is now recovered in the processes of coking which are becoming more and more universal. The amount of benzol which at the present time is being produced in Germany totals up to about 5 million gallons per annum; and this quantity will be increased more than fourfold as the various coke-works, which at present do not recover the bye-products, are forced by competition to erect recovery plant.

The wonderful carburetting power of benzol is well known, as we all recognize that a very large proportion of the total illuminating power of coal gas is due to the presence of a minute trace of its vapour carried in suspension; and with 90 per cent. benzol at its present price, it is far and away the cheapest enriching material that can be obtained. At several Continental works, they are making good use of the present low price to utilize it in the most effective possible way for cheapening and increasing their gas production.

Away on the shores of the Baltic, in Northern Prussia, close to the Russian frontier, stands the picturesque old town of Königsberg, celebrated in literature as the dwelling place of the great philosopher Kant; and here the scientific ability of Herr Director Krieger and of Herr Kobbert, the Chief Engineer of the Corporation Gas-Works, have led the way in the introduction of benzolized water gas as an adjunct to the gas manufacture. Producing the water gas from a pair of Dellwik-Fleisher generators, each capable of yielding 20,000 cubic feet per hour, the gas is passed through a scrubber into a relief holder. The water gas then flows in from the relief holder to the benzolizing-house, in which benzol supplied from a "Munich" reservoir at a suitable rate of flow, is vapourized in a Leybolt carburettor, and the vapour mixed with the water gas.

The benzolized water gas and the coal gas are at these works mixed at the entrance to the main gasholders, which ensures greater uniformity in composition in the finished gas. But it would, of course, be equally possible to mix the blue water gas and the coal gas as they enter the holder, and to benzolize the mixture as it left the holder for distribution, as is often done with Maxim-Clark carburine enrichment.

At the Königsberg works, they are blessed with a well-appointed chemical laboratory, into which pipes from the water-gas holder, benzolized water-gas main, coal-gas main, and outlet of holder are led, so that it is possible to check every stage in the process and to determine exactly what is taking place; and I have to acknowledge my indebtedness to the Director and Herr Kobbert for placing the experimental laboratory at my disposal, and rendering me every assistance in their power during my visit to Königsberg.

The conditions which led to the introduction of water-gas plant were that the works had grown to their full limit, and the holder capacity was only about 30 per cent. of the output. The water-gas plant is, therefore, used during the hours of consumption to add to the output. The candle power of the coal gas varies from 16 to 18·6 candles (18 to 21 Hefners), and the mixture as sent out varies from 18 to 19·5 candles (20·3 to 22 Hefners). This result is attained by the use of 20 grammes of benzol per cubic metre of mixed gas, or 0·139 gallon per 1000 cubic feet.

At the gas-works at Erfurt, which I have also personally visited and where I received the greatest courtesy from Herr Director Martin, the same process is in use with one small but important modification, and that is that the blue water gas, instead of being benzolized and then added to the coal gas, is passed into the foul main during the process of gas making. This was found to give a distinct saving in the amount of benzol afterwards needed in raising the candle power of the mixed coal and water gas, owing to the water gas becoming to a slight extent carburetted with the benzol in the tar vapours which otherwise would condense with the tar. The factors which may be taken into consideration in arriving at the economic value of the process for English practice are best stated as follows.

Using a good English gas coal and the ordinary heats, 10,000 cubic feet of 16-candle gas are obtained per ton of coal. Mixing this with 25 per cent. of blue water gas, the illuminating value is reduced to 12·4 candles; and to carburet this up to 16 candles once more, a gallon of benzol is required per 10,000 cubic feet of the mixture :—

7500 cubic feet of coal gas in holder at 11d. per 1000	6s.	10½d.
2500 cubic feet of water gas at 3½d. per 1000, including royalty	0	8¾
*1 gallon benzol	0	10
Charges on carburettor, mixing plant, &c.	0	0¾
Cost of 10,000 cubic feet of mixed gas	8s.	6d.
Or 10·2d. per 1000 cubic feet.		

* I have taken the price of 90 per cent. benzol at 10d. per gallon; but it is quoted this week at 6d., and last week was even lower.

So that, when increase in volume and not enrichment is the desideratum, it may be taken that a saving of ¾d. per 1000 cubic feet is obtained; and where the initial cost of coal gas is greater than 11d. per 1000 cubic feet in the holder, the saving is, of course, increased.

It is well at this point to consider how far the experiments which have from time to time been carried out on enrichment by means of benzol support these really wonderful results, which seem to show that at the present moment, when any other form of enrichment costs from 1d. per candle per 1000 cubic feet upwards, 3·5 candles may be obtained at the same price by means of benzol. Benzol has a specific gravity of ·85. There are, therefore, 8·5 lbs. to the gallon, or 59·500 grains; and a cubic foot of benzol vapour, at 60° Fahr. and 30 inches pressure, weighs 1444 grains.

In a research upon the illuminating and enrichment value of hydrocarbons made about twenty years ago by Dr. Knublauch, then Chemist at the Cologne Gas-Works, he found that benzol, when used to enrich coal gas, had a value of 14·15 candles for a consumption of 120 grains; and taking these figures, a gallon of benzol has an enrichment value of 7017 candles.

In the Erfurt practice, one gallon of benzol is added to 10,000 cubic feet of the mixture of coal gas and water gas in order to raise it from 12·5 to 16 candles—*i.e.*, 3·5 candles, and $\frac{10,000}{5} \times 3{\cdot}5 = 7000$ candles, which is in exact accordance with Dr. Knublauch's determination. When it is desired to raise the candle power, enrichment will cost with benzol at 10d. per gallon, 0·3d. per candle per 1000 cubic feet; so that by this process a full 16-candle gas could be put into the holder at the same price as a 16-candle gas made directly from coal.

It must be clearly borne in mind that these enrichment figures are for the mixture of coal gas with 25 per cent. of water gas, and not for water gas alone. As early as 1878, the late Sir Edward Frankland and Dr. Thorne showed that when a definite quantity of benzol vapour was mixed with methane it gave approximately 33 per cent. more light than when mixed with hydrogen or carbon monoxide. Later on, Dr. Percy F. Frankland showed that the same phenomenon held good in diluting ethylene; while I have shown that with acetylene it is the same. In every case a higher illuminating power is obtained when a highly luminous hydrocarbon is added to methane, or a mixture containing a fairly high proportion of methane, than when hydrogen or carbon monoxide is used as the diluting gas. This, of course, holds good for water gas; a far higher illuminating power being obtained from the addition of a given quantity of benzol to coal gas with its 34 per cent. of methane than could be obtained from water gas by the addition of the same quantity—the original candle power of the coal gas being left out of the question.

When water gas is benzolized before admixture with coal gas, as is done at Königsberg, if the candle power is taken it is found to be only about 9 candles. Yet the addition of from 17 to 20 per cent. of this to the coal gas having a value of 16 candles will yield a mixture of over 17 candle power; the methane in the coal gas having brought out the illuminating value of the benzol in the water gas. It has been more than once suggested that a town supply of water gas carburetted with benzol might be sent out without admixture with coal gas; but this would require so much benzol that a carburetted water gas made by such a process as the "Humphrey and Glasgow" would be much more economical, as the oil gas used in this case to enrich the water gas contains sufficient methane to bring out the illuminating power of the unsaturated hydrocarbons present.

The flame of coal gas enriched by carburetted water gas is shorter and brighter than a flame of the same lighting power of coal gas alone. For instance, when burnt in the London argand at the rate of 5 cubic feet per hour, the flame given by a 16-candle pure coal gas is 3 inches in height; while when enrichment is secured by mixing with it 30 per cent. of a 22-candle power carburetted water gas, the 16-candle flame is only 2·6 inches in height. From this, it seemed highly probable that, when coal gas was diluted with benzolized water gas, the same shortening action on the flame might take place; but from experiments made at Königsberg, I was unable to detect any difference in the height of the two flames of equal illuminating value—one flame being the undiluted coal gas, and the other coal gas and benzolized water gas.

Another point of difference that must be borne in mind between carburetted water gas and benzolized water gas is that, with carburetted water gas of 22-candle power used as an enricher, almost any percentage may be used in admixture with coal gas without upsetting in any way the combustion of atmospheric burners such as are so largely used now for incandescent mantle lighting. While with benzolized water gas, it is inadvisable to use more than 30 per cent., as above that percentage atmospheric burners begin to show a tendency to flash back—*i.e.*, for the gas to fire at the gas injector at the bottom of the burner tube.

In connection with the process of benzolizing water gas, the question naturally arises as to how the enriched gas compares in travelling power with gas enriched by any other process. You have nearly all had experience in carburetting gas with carburine; and I think it may be accepted that it requires 1·25 gallons of this light hydrocarbon to enrich 10,000 cubic feet of coal gas one candle, while the same result can be obtained with 0·3 gallon of benzol. In other words, benzol is four times as valuable an enricher.

The vapour tensions of carburine and benzol, upon which their carrying properties depend, were given by Mr. T. S. Lacey in a valuable paper read before the Institution in 1892, as follows:—

Vapour Tension in Inches of Mercury.

Temperature. Deg. Fahr.	Carburine.	Benzol.
32	2·5	1·1
40	3·0	1·5
50	3·9	2·0
60	4·9	2·7
70	6·1	3·5
80	7·5	4·7
90	9·3	5·7

This shows that at the freezing point the gas will only carry less than one-half as much benzol vapour as carburine vapour. But as the benzol has four times the illuminating value of the carburine, the gas will show nearly twice as much enrichment with benzol under these circumstances as with carburine.

As regards the use of the mixture of coal gas and benzolized water gas for fuel and power, the difference in practice would be hardly perceptible—

Net Calorific Value.

Blue water gas	280·8 B.T.U.
Coal gas	573·0 ,,
Benzolized water gas	359·0 ,,
Mixture	544·8 ,,

I have only visited Königsberg and Erfurt; but I am informed that the process is either at work, or plant is in course of erection, at six other places, including Lyons. All the time that the price of carburetting oil remained at a reasonable figure, carburetted water gas has been a valuable ally to the gas manager; but now that its universal increase in price has caused gas men, even in America, to look with doubt upon the possibility of continuing its use, benzolized water gas bids fair to take its place, and to tide the gas manufacturer over the trying time that seems to be in store for him.

Great as has been the help afforded to the gas manager during the past ten years by the aid of water gas carburetted by the decomposition of oils in such perfectly arranged generators as those given us by the ingenuity and ability of American engineers, and great as the success of the present European practice of benzolizing a mixture of coal gas mixed with 20 to 30 per cent. of blue water gas promises to be, yet I feel that we now only stand upon the threshold of the domain in which water gas will prove itself an ally more powerful than any the gas manager has yet had.

So far, coal gas has well held its own. Confronted by the powerful rivalry of the electric light, the gas manager has developed the use of gas for fuel purposes, and by the aid of the incandescent mantle has carried the war well into the enemy's camp. But this was only possible with cheap gas. Any serious increase in price must of necessity militate against the gas industry; and with the rise in the cost of coal, one's thoughts are naturally turned with almost feverish anxiety to the possibility of reducing the cost of manufacture.

The day may come when all coal will be converted into gaseous matter at the pit's mouth, and the atmosphere cleansed by the universal adoption of gas as a fuel and a source of power. But the time is not yet ripe; and vested interests are too strong to make this likely in the near future. Any help that comes must be within the four walls of our

own gas-works, and to be of lasting service must be free from the uncertainty due to the fluctuating price of enriching materials. We hoped much from carburetted water gas, and we got a good deal; and now the rising price of oil has limited its utility. We hope more from benzolized water gas; and I have shown you the grounds for thinking that it will remain at a usable price. But are there no points that we have overlooked in our own practice? Is there no method by which we can more fully utilize the illuminating materials stored within the coals that we carbonize? I think the answer is in the affirmative.

The process of carbonization, which is the heart of the whole system, has undergone no practical change from the inception of the industry to the present time. Iron has given way to fireclay as the material of which our retorts are made, and, as a further tribute to progress, some of us tilt our retorts to allow gravity to take some of the work off our hands. But the changes going on within the retort as heat divorces the constituents of the coal into the products we know so well, are so complex, and so beyond our ken, that we have looked upon carbonization as something too sacred to tamper with. We know that as we distil the coal about 17 per cent. of its weight comes off as gas, and that another 5 per cent. goes to form tar; and many have been the attempts to utilize tar once more for the production of hydrocarbon gases—it being realized that there was more carbon combined with hydrogen in the 140 odd compounds that go to build up the 10 gallons of tar than was present in the 10,000 cubic feet of coal gas that we obtain from the ton of coal, and that if this tar could be again gasified, an enormous gain in illuminating power could be achieved. I need not dwell upon the result of these experiments, as you all have them by heart. But there is another side to the question at present practically untouched, which shows a wonderful field of promise.

Any worker in the laboratory will tell you that the addition of a small quantity of a solvent to a liquid will often prevent the formation of a precipitate; while, when once the precipitate is formed, far greater difficulty is experienced in obtaining its solution. We may apply this to many of the constituents of tar which, formed by the overheating of the gases distilling from the coal as they pass along the crown of the retort, can never again be properly gasified; while had the proper means been taken to prevent their formation, the constituents would have remained as valuable illuminants in the gas, and have been ten times the value to the gas manager that their products are to the tar distiller.

If bituminous coal is distilled at a low temperature, the tar is found to contain considerable quantities of light paraffin oils; and there is no doubt that paraffin hydrocarbons are present in the original coal. These paraffins, under the influence of heat, split up into simpler members of the same series and into olefines; and if we imagine the action in its simplest form, we should have the gases as they were evolved consisting of (say) ethane and ethylene. These have now to pass down the heated retort on their way to the ascension-pipe, and the contact with the heated sides of the retort, and the baking from the radiant heat in the retort, set up an infinity of changes.

Ethane, when heated to this degree, splits up into ethylene and hydrogen; while ethylene decomposes to methane and acetylene, and the acetylene at once polymerizes to benzene, styrolene, retene, &c. A portion also at the same time condenses and, losing some hydrogen, becomes naphthalene, and the compounds so formed by interactions among themselves build up the remainder of the hydrocarbons present in the coal tar; while the organic substances containing oxygen in the coal break down, and cause the formation of the phenols in the tar.

There is very little doubt that the general course of the decomposition follows these lines. But any such simple explanation of the actions taking place is rendered impossible by the fact that, instead of the breaking down of the hydrocarbons being completed in the coal, and only secondary reactions taking place in the retort, in practice the hydrocarbons to a great extent leave the coal as the vapours of condensable hydrocarbons, and that the breaking down of these to such simple gaseous compounds as ethylene is proceeding in the retort at the same time as the breaking up of the ethylene already formed into acetylene and methane, and the polymerization of the former into higher compounds. Starting with a solid hydrocarbon of definite composition, it would be theoretically possible to entirely decompose it into carbon, ethylene, methane, and hydrogen, and, by rapidly removing these from the heating zone before any secondary actions took place, to prevent the formation of tar. But any such ideal is quite hopeless in practice, as the coal is not a definite compound, and it is impossible to subject it to a fixed temperature.

If the retorts are at a temperature of 1000° C. when the charge of coal is put in, the temperature of the distillation will vary from about 800° C. close to the walls, to about 400° C. in the centre of the coal; and in the same way in the space above the coal the products which come in contact with the sides of the retort are heated to 1000° C., while the gas near the coal is probably only heated to 600° C. Hence we find that the tar is formed of two distinct sets of products—the first due to incomplete decomposition, and the second to secondary reaction due to the products of the decomposition being kept too long in the zone of heat.

We can at present do nothing to prevent the formation of the primary products in the tar. But I believe it is easy and possible to prevent the building up of the secondary compounds, and this would at once give a great increase in illuminating power to the gas. Consider for one moment the conditions existing in the retort, and then ask yourselves how it is possible to look upon the present method of carbonization as a rational process likely to give uniform or satisfactory results. Every foot of gas that comes from your retort has been subjected to different conditions of temperature—partly radiant heat and partly heating by contact with the red-hot sides and top of the retort—and every portion of the gas has been exposed to the heat for a varying length of time.

The portion of gas yielded by the first few feet of coal in the retort is hurried out by the rush of gas from the coal behind it, and reaches the ascension-pipe in nearly the condition in which it left the coal; having only been exposed to heating in the gaseous or vaporized state for probably one or two seconds at most. On the other hand, the portion of gas from the charge farthest from the mouth of the retort has had at first nothing to hurry it on, and only begins to travel quickly in the retort as its bulk is swelled by mingling with gas from the portions of the coal over which it has to pass, with the result that it takes probably a minute before it reaches the ascension pipe. During this period, it is not only baked by the radiant heat, but is also decomposed by contact with the heated retort surface during a travel of something like 10 feet. Between these two extremes, every portion of the gas is made under different conditions of time and temperature, while, if the coal is not fed properly and banked at the end of the retort, or if you are using machine-fed double-ended retorts and there is a slack portion or space between the ends of the two charges, you have the finest naphthalene factory in the world.

You know by experience that if you fill your retorts so as to leave only the minimum of space above the coal, the naphthalene trouble disappears simply because the area for the passage of the gas is small and the gas-yielding material large in quantity, with the result that the rate of flow of the gas is rapid and the period of baking minimized; and you also many of you know that if you only put a 3-inch layer of coal at the bottom of your retort, and use the same temperatures, you would have a surfeit of choked ascension pipes and naphthalene all over the district, because, by increasing the area for the passage of the gas, you slow down its flow and expose it to the baking for a longer period.

If you could divide the charge in the retort into three portions, and could keep the rate of flow the same as at present, and yet keep the gases from each portion separate, you would find that the portion nearest the mouthpiece gave you nearly all the unsaturated hydrocarbons present in the gas; from the second you would obtain methane and a trace of benzene; while the back end of the retort would yield practically nothing but hydrogen, naphthalene, pitch, lamp black, and retort carbon—in other words, you are wasting half the illuminants obtainable from the coal.

I have been for some years making experiments and collecting the data which bear me out in the facts I am now bringing before you; and in bringing forward what I consider a satisfactory solution to this important phase of gas manufacture, I shall not propose any radical alterations in your plant or methods that would entail any prohibitive or even great expenditure.

In a paper I had the honour to read before you in 1892, on the use of oil for carburetting gas, I pointed out that "on a manufacturing scale, better results may be obtained by 'cracking' the oil vapours in an inert gas—such as

hydrogen, carbon monoxide, or water gas—which, by separating and partly protecting the molecules during their decomposition by heat, increase the range of temperature within which the best results can be obtained, and prevent excessive breaking down of the hydrocarbons and consequent loss of illuminating value." That this is the case, is shown by the following experiment. A known volume of coal gas was taken and passed through a porcelain tube, packed with broken pieces of the same material, and heated to a bright redness. A copious deposition of carbon was the result; and the gas, after cooling, burnt with an almost non-luminous flame. The same volume of coal gas was now diluted with twice the volume of hydrogen, and was passed, at the same rate of flow as before, through the tube heated to the same temperature, when only 1-200th of the amount of carbon was deposited.

Ample verification of this interesting and important fact can be obtained from data collected in carburetting water gas in several of the best-known systems, in which the oil vapours are carried by the hot water gas through heated chambers in which the decomposition of the oil vapours to permanent gases is effected, and yields results which could not be approached by making the oil gas and water gas separately and afterwards mixing the two.

Taking, for instance, the Russian distillate oil, the best results obtained by cracking it by itself were 92 cubic feet of 46-candle power gas per gallon, which is equal to 846·4 candles per gallon; while the same oil, when cracked in a current of water gas in the improved Lowe apparatus at Beckton, yields, according to the figures given by Mr. Goulden in his paper read before this Institution in May, 1891, no less than 1200 candles per gallon, or an increase of nearly 42 per cent.

The working from which Mr. Goulden quotes these results, however, was on a very large scale, and under the best conditions. In order, therefore, to obtain comparative results, it was necessary to contrast the result obtained by cracking the oil alone and also in the presence of an inert gas under precisely similar conditions.

For this purpose, oil was cracked alone in a short experimental retort and collected; while, after a time—the rate of flow of oil and temperature being kept constant—a slow current of hydrogen was allowed to flow in known quantity through the retort, and the resulting mixture of gases collected in a separate holder. The results so obtained were—

Distillate oil cracked alone yielded per gallon 84 cubic feet of 42·2-candle power gas = 709 candles.

Distillate oil, cracked in an atmosphere of inert gas, yielded 92 cubic feet of 53·8 candle power gas = 989·9 candles.

There is no doubt but that this method of obviating over-decomposition by heat can equally well be applied to coal gas. Indeed, fifty years ago the secret of making this considerable saving was nearly won; and had there been anyone at that time who clearly grasped the actions taking place during carbonization, I should not have had the pleasure of bringing these ideas before you to-day.

Some of you will still remember White's hydrocarbon gas, over which a heated controversy raged in the early fifties. White connected two retorts end to end, heated them to the highest temperature he could, and made water gas in one by passing steam over red-hot charcoal. He then decomposed resin in the second retort, and washed out the resin gas as it was formed by the water gas mixed with steam. At a later date, he abandoned resin and substituted cannel coal. The late Sir Edward Frankland, then commencing his career as a Chemist, made an exhaustive series of experiments with the plant, and obtained such remarkable results that attention was fully aroused to its importance. But the results obtained by other observers did not bear out the promise of its youth. Later on, Mr. Thomas G. Barlow fully examined the process and found the cause of the discrepancies, but showed that the technical drawbacks then existing rendered its practical application extremely difficult, and the process sank into the lumber room of the past. Fifty years of work, however, have wrought a great change, and the difficulties then existent have now disappeared. The mistakes made by White are perfectly manifest; and the time is ripe, knowing what we are aiming at, for us to utilize the principle that underlay his method.

It is clear that what he was doing was to hurry the products of the destructive distillation of the coal out of the baking influence of the retort, by pushing them forward by the stream of water gas, which not only increased their rate of flow, but, by diluting the hydrocarbon molecules, prevented them from polymerizing and breaking down.

Some of the results obtained by Frankland were extraordinary. For instance, retorting Methil cannel under ordinary conditions in his experimental retort, he obtained 9560 cubic feet of 27·8-candle power gas per ton; while using water gas, he got 26,400 cubic feet per ton of 21-candle power gas. Mr. Barlow did not obtain such good results, but still came to the conclusion that properly worked the gain would be 40 to 50 per cent. in the total illuminating value.

Looking back to the methods employed, the wonder is not that observers differed, but that they got any result at all. Instead of being able to exactly apportion the volume of water gas to the volume of cannel gas distilling from the coal-retort, the supply of water gas was most irregular, varying from 160 to 870 cubic feet per hour, and generally giving the largest yield when the smallest quantity was required; while the cardinal error that wrecked the whole process was that steam was injected with the water gas under the impression that it would attack and destroy the tarry matter. In point of fact, it partly attacked the illuminants, but chiefly devoted itself to oxidizing the carbon monoxide into carbon dioxide, with the result that 16 to 20 per cent. of the latter was often found in the gas, and had to be removed by lime purification before satisfactory illumination could be obtained—a detail which effectually also removed the profitable bearing of the scheme.

In order to successfully carry out the process that I now bring before you, and which consists in hurrying the gas out of the zone of heat and diluting it by a stream of water gas, the water gas used must contain but little carbon dioxide and no free steam, and must be heated to nearly the temperature of the gas in the retort. For this purpose, the Dellwik-Fleischer water-gas generator offers enormous advantages, as not only does it produce the water gas at one-half the price of an ordinary generator, but, properly worked, it does so with a remarkably small percentage of carbon dioxide. Many of the experiments I have made with it give less than about 3 per cent., while the average, working over a long space of time, is below 5 per cent., and by a very slight modification in the handling of the plant it could be reduced down to the same amount as is present in crude coal gas. Moreover, should there be even 5 per cent. of carbon dioxide in the water gas, contact with the hot tar vapours in the retort would reduce it to carbon monoxide, so that this would not add anything to the cost of purification.

From the generator, the water gas is led, as usual, to the relief holder, which need only be of comparatively small size, as it is intended to act more as a regulator than as a store. From this, mains are led along the front of the bench of retorts; a pipe passing from the main to each mouthpiece, where it can be led in by the side of the ascension pipe and along the crown of the retort in such a way as not to interfere with charging and drawing. Some 2 or 3 feet from the mouth of the retort, small holes are drilled in the underside of the delivery pipe; and these holes are continued at intervals of some 6 inches to the end of the pipe, which is left open, and is either at the rear of a single-ended retort or at the middle of a double-ended one. While between the water-gas main and the mouthpiece of the retort is a valve by which the supply of water gas can be cut off or regulated.

In carbonizing, as soon as the lid is made tight, the water gas is turned on, and the flow regulated in amount to about 20 to 30 per cent. of the yield of gas from the coal in the retort; and for the first four hours of the carbonization the water gas is kept flowing at about this rate. At the end of that period, the water gas can be reduced, either to a very small flow or cut off altogether. As the gas yielded during the last hours of the charge is only coming from the small portions of uncarbonized material in the centre of the lumps of coal, and having to pass through the casing of red-hot coke that surrounds it, it is rendered practically worthless except for bulk before it escapes from the mass.

From this brief description of my ideas, you will see at once that the expense and the amount of alteration necessary are very small; and I firmly believe that the gain will go far towards neutralizing any loss that the increase in the price of coal may entail in the near future. It must be remembered, however, that results such as those obtained by Frankland, who showed a gain amounting sometimes to nearly 200 per cent., must not be expected, as you are

dealing with ordinary gas coal and not with a rich cannel; and I think you will agree with me that if this modification of the process of distillation will enable you to make 13,000 to 14,000 cubic feet of gas per ton of coal of the same, or 1 candle better, quality than you are now producing, and with the increment in volume only costing 3d. to 4d. per 1000 cubic feet, a step of the most enormous importance will have been taken, while any further increase of illuminating power that is needed can easily be obtained by merely benzolizing the gas.

I conceive that the function of a lecture such as I have had the honour of delivering to you this morning is either to bring before you the details of new processes which have been employed beyond the range of your personal observation, or to afford food for thought and experiment during the quiet period before us, and I can only hope that on the present occasion I have succeeded in doing both.

The PRESIDENT proposed a hearty vote of thanks to Professor Lewes for his lecture. The members had not only had an intellectual treat, but had heard something which had interested them, and had put into their minds hopes for the future. He could not help saying that what Professor Lewes had stated would in all probability be tried before very long by many of them. It was, of course, easy to tell them how a thing ought to be done; but it was not so easy for them to put it into practice. He had shown them that the theory of the thing was correct; and he (the President) had no doubt that in a few years he would see it put into practice.

Mr. GEORGE LIVESEY, in seconding the proposition, said he thought he was the only one who knew practically anything of Stephen White's process. It was one of his first duties, as a lad under his father, to record the experiments made under that process. He could well remember Stephen White and Dr. Frankland, as he then was, carrying out these experiments. There was one thing he desired to point out. They tried to remove the oxygen by passing it over red-hot iron. They filled the retorts with red-hot old iron chains, &c.; but he had never before heard the version of carbonic oxide as set up by Professor Lewes. He thought they were very much indebted to the lecturer for bringing out this point. It was just what they wanted—the means of making gas on their own premises in large quantities without being so largely dependent on the supplies of coal. Professor Lewes said the theory about the tar was to prevent its formation. Forty years ago it was said that the lines on which they ought to work were to prevent the tar from being produced. The increased scientific knowledge which Professor Lewes had brought to bear on the subject now confirmed this view. He (Mr. Livesey) had great pleasure in seconding the vote of thanks. They were much indebted to the Professor, and he hoped good results would follow from his lecture.

The resolution having been carried unanimously, amid loud applause,

Professor LEWES said he had to thank the members, as he had so often done in the past, for their kindness in listening to him. He could assure them they had at the present time an epoch in gas manufacture, when they had a demand for theory as well as practice. They had reached a point in gas making where they knew almost everything that was to be known in methods; and the opening of new doors must to a considerable extent depend on theorizing. He hoped he had not let his hobby-horse run too freely; but he thought that, in the ideas he had put before them, they really had the gist and the germ of a most important point of progress. It was interesting to him to know that Mr. Livesey had to do with White's process in the early fifties. As long as they had the water gas hot, and put in the right proportion, while they had a rush of gas coming off the retort, they would find that they would be doing what they required—they would be getting over the naphthalene trouble. If they filled up their retorts, they would have no naphthalene produced; but if they put 3 inches of coal in them, they would have a glut in the ascension-pipes, as there was no time for the taking up of naphthalene. If there were 3 inches of coal in the retort, they had a big area; and the baking of naphthalene went on briskly. If they left a space between the two ends, he thought the practice would tell them they got naphthalene formed in very considerable quantities. He tendered his thanks for the hearty vote accorded to him by the members of the Institution.

PAPERS READ.

THE ENRICHMENT OF COAL GAS.

By GEORGE LIVESEY.

The original object of this paper was to question the advisability of supplying gas of higher quality than can be obtained from the available supply of coal. A wider scope may, however, be given to the inquiry, because the great extension of the uses of gas now in progress, and the enormous development of its light-giving power by the incandescent system, raise the question whether the object should not be to supply gas at the lowest possible price regardless of its illuminating power. In short, is not the time within measurable distance when non-luminous gas will be the great desideratum of the public? If so, should not the necessary educative process be energetically undertaken, and at once? Our Transvaal of ignorance and prejudice, manifested in the antagonism of local authorities towards gas companies, must be conquered if the best is to be done to meet the needs of the consumers of gas.

The policy of half-a-century has to be reversed. The question of illuminating power was first brought into prominence by the advent of the Great Central Gas Company, for the supply of the City of London in 1850, when gas of 12 wax or 10 sperm candle power at 4s. per 1000 cubic feet was offered in competition with the gas of the Chartered and the City Gas Companies at 6s. per 1000 cubic feet. In 1853 special voluntary arrangements for testing were made by the four South London Companies when they districted; and by the Metropolis Gas Act of 1860, a standard of 12 sperm candles, and provisions for testing, were adopted. Since that date Parliament has recognized as a public necessity that the gas supply must be a monopoly; and almost always local authorities have opposed the grant of parliamentary powers to gas companies, with the object of restricting capital, reducing price, and increasing illuminating power. With the last mentioned they have been particularly successful, presumably because it has been most erroneously supposed that the cost of any increase of illuminating power must be borne by the companies; and the result now is that almost everywhere, and particularly in London, partly by alterations of the photometer, enrichment is increasingly necessary—the required quality not being obtainable from the available supply of coal.

To ascertain whether such enrichment is advisable, the following questions need an answer: 1. What are the various forms or methods of enrichment? 2. What is their relative effectiveness as to (*a*) Uniformity? (*b*) Reliability or permanence? (*c*) Cost? 3. Is the enrichment worth to the consumer what it costs him?

1.—Many methods of enrichment have been tried—the idea of getting it from coal tar has fascinated many minds, and is as old as the public supply of gas; but it never has held, and certainly does not now hold, the field in any of its forms. The direct destructive distillation of oil has also given promise of satisfactory results, but has made very little headway. There are, in short, only three systems in general use—viz., by an admixture of cannel with the coal to be distilled; by the injection of the vapour of petroleum spirit into the gas prior to its being sent into the district; and by the manufacture of a percentage of carburetted water gas.

2. Relative effectiveness. Cannel secures uniformity in the quality of the mixture, and is both reliable and permanent; but its cost puts it out of court. When cannel was available at the price of ten to twenty years ago, it was generally considered that the cost—taking into consideration its price and the loss on coke, &c.—of each additional candle was quite 2d. per 1000 cubic feet. It went out of use because the increasing demand put up the price to a prohibitive figure, and would do so again immediately if it were to come into demand as an enricher.

Enrichment by petroleum spirit costs about 1d. per 1000 cubic feet per added candle. Benzol at its present price is perhaps a little cheaper; but although, probably, spirit vapour can be mixed with tolerable uniformity, it appears to be unreliable, and cannot be regarded as permanent—that is, there is no certainty that the gas will carry this vapour enrichment throughout the area of supply, and in condensing it probably carries down with it some of the hydrocarbon of the gas. Reliable evidence as to its want of efficiency is furnished by the fortnight's experiment in

1894, when all the South Metropolitan gas was sent out unenriched, and the succeeding fortnight, when it was enriched with spirit as usual. The tests by the portable photometer were practically the same in both cases. The portable photometer results—although, as an instrument, it corresponds exactly with the official photometer—cannot be accepted as accurate, because the instrument is used under improper conditions. Still, when compared with itself under similar conditions (as in these two series of tests), the comparison holds good. Therefore, if this complete practical experiment gave, as is believed, reliable results, the conclusion is inevitable that enrichment by spirit vapour is useless, and simply a waste of the consumers' money.

Enrichment by carburetted water gas is involved in some obscurity as to cost. Those who use it, for some reason, carefully abstain from giving the necessary particulars in their published accounts. The suspicion consequently arises that it is not so cheap as its advocates wish it to appear. But suppose, for the purpose of this paper, and in order to avoid discussion on this interesting point, that its cost is about the same per added candle as petroleum spirit, or 1d. per 1000 cubic feet, which, in itself, would not be a serious objection to its use as an enricher. Neither can it be urged that it is not a permanent gas. The objections to its use lie in other directions—viz., the public prejudice as to the danger of its use, owing to the deleterious nature of carbonic oxide; its greater specific gravity and lower calorific value; and the practical difficulty of ensuring uniformity in the mixture of coal gas and water gas, when the latter is used as an enricher. For instance, 75 per cent. of 14-candle coal gas would need 25 per cent. of 22-candle water gas to give an average 16 candles by calculation, or perhaps rather more in practice, if (and this is the point) uniformly mixed. But how can this uniform mixing be ensured? The quality will, in all probability, be constantly varying, owing, it may be, to the difficulty of mixing, or, it has been said, to stratification while standing in the gasholders.

At any rate, there are serious objections to all three methods of enrichment; for while the cost of cannel puts it out of court, spirit is useless from its uncertainty and want of permanence; and carburetted water gas is objectionable from its nature and the difficulty and uncertainty of mixing. And although hitherto its cost may not have been excessive, the recent more than doubling of the price of oil (which is far more likely to be permanent than the present increase in the price of coal) will very likely render the continuous use of carburetted water gas impracticable.

Such are the principal objections and disadvantages of enrichment. The arguments in its favour must be left to its advocates. Certain it is that for a very large proportion of the gas consumed, it is a useless expense. No one can seriously argue that the slightly higher calorific value of enriched gas, even if the enrichment reaches the consumers, is desirable for heating, cooking, power and trade, or manufacturing purposes. A lower price rather than the higher quality is what consumers want; and as to incandescent lighting, experiments made in Germany (and corroborated in England) have proved that with the Welsbach burner the light actually increases as the illuminating power of the gas diminishes.

To illustrate this point, diagrams showing the result of the German and the English experiments have been prepared; for to a fact of such great importance special prominence must be given. Further, consumers have it in their power, even with ordinary burners, to increase or diminish the light obtained from the gas to a far greater extent than the difference produced by enrichment.

In illustration of this point, the burners (flat flame) of fifty consumers taken indiscriminately, who lately complained of a bad light, were tested. The illuminating power yielded by these burners ranges from 6 to 17 candles. The gas used was of 16-candle power, burnt on the best conditions as to pressure and quantity for obtaining the most light—more than the consumers would obtain, because they would not burn under those conditions. Of the fifty burners, the highest result per foot of gas, calculated to 5 feet per hour, was 16·9 candles, and the lowest was 6 candles. There were three over 16 candles, two under 7 candles, and 15 (or 30 per cent.) under 10 candles. These complaints, as is the case with all others, were remedied, not by increasing the illuminating power of the gas, but either by changing the burners or improving the supply of gas. To this audience it is unnecessary to refute the absurd statements of Mr. Dibdin in his recent evidence—that, with flat-flame burners, a reduction of 1 candle necessitates the use of 18 per cent. more gas to obtain the same amount of light, and 35 per cent. more for 2 candles below 16 candles. At this rate, by the time the gas reaches 10 candles, with the standard argand, it is an interesting question whether there would be any light with a flat-flame burner. This is a striking instance of what some men imagine they can prove by their experiments.

There is yet another strong reason against enrichment. The best kinds of gas coal are becoming scarce, and inferior gas-making seams are becoming more and more the source of supply. If, therefore, the policy of pressing for higher illuminating power is continued, or even if the present standard is maintained, the cost of coal must permanently increase. The price of gas must rise, and gas undertakings generally must necessarily drift more and more into the power of the coalowners. They are just now giving us an idea how they would use that power.

Lighting Effect by Incandescent Burners, and Fuel Value of Coal Gas Deprived of Illuminating Power.

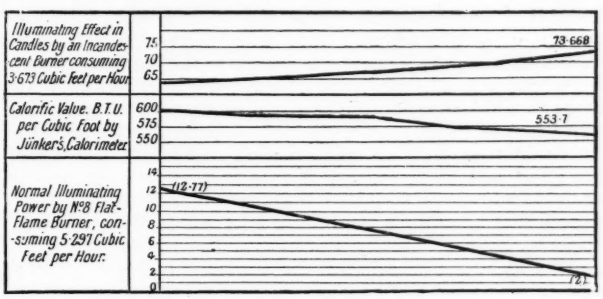
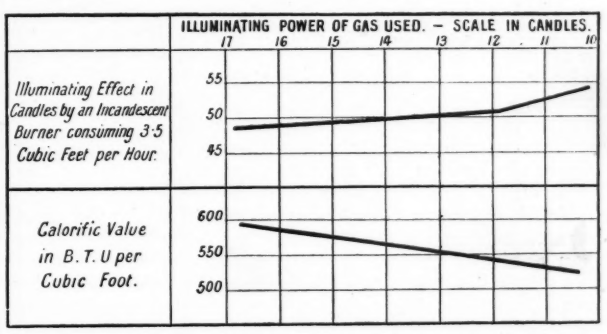


Diagram prepared from experiments made at Dessau, in May, 1899, by Herr Schaeffer, under the direction of Herr W. von Oechelhaeuser, with an Auer mantle previously used for 300 hours. The gas was progressively deprived of its benzol by being passed through "green oil."



Tests made by the South Metropolitan Gas Company, April, 1900.

Present experience shows that when coalowners have the power they do not scruple to use it, with few exceptions, without the slightest consideration for their old customers who have treated them fairly in the past. Their present conduct will not be forgotten when the inevitable depression in trade returns; and they will probably have cause to rue it. The moral for the gas industry is that it must, by all means in its power, free itself from their grasp, by widening the area whence it draws its raw material.

Everything, happily, points to the reversal of the policy of high illuminating power of the last half-century. Enrichment is costly, difficult, and uncertain. Consumers do not want it. Their desideratum now is an abundant supply of cheap gas of low illuminating power—its calorific value having become its most necessary quality; while the slowly increasing difficulty of getting suitable coal, renders a reduction necessary. The conviction in its favour among gas manufacturers has grown most strikingly during the last six or seven years; and it is for them to take the lead in the movement, for they are the only men who understand the question. Attacked intelligently and persistently by them, prejudice and ignorance must yield, though it may be some time before the entanglement of our Ladysmith is relieved. The gas industry is hampered and confined by the bonds which were thought

necessary to protect the public from a monopoly 30 or 40 years ago. Gas supply then was truly a monopoly; for as a means of producing artificial light gas was practically without a competitor, and it was used for little else than lighting. Within the last 30 years, two active and formidable lighting competitors have entered the field; and gas is, as it were, bound with the grave clothes of the dead past, while its opponents are free. Gas asks for fair play—for the abolition of useless restrictions that hamper its development, and that were imposed in the supposed interest of the public; but whatever may have been their use in time past, they certainly now (heating gas being chiefly wanted) work to the public disadvantage. The chief of these restrictions is the requirement to give a higher nominal illuminating power than can be obtained from the available supply of coal; and the removal of this limitation to freedom of action is the pressing necessity of the immediate future.

Discussion.

Mr. W. Foulis (Glasgow) said one thing had struck him—viz., that the experiments the results of which appeared on the diagram certainly did not correspond with some which he made several years ago. Probably the difference was due to the method of adjusting the air and gas supplied to suit the different qualities of gas. He found that, within certain limits, there was a slight increase as the quality rose, and this was what one naturally expected. But unless the air supply of the bunsen burner were properly adjusted, one could quite understand that there would be a reduction in the illuminating power. He had great sympathy with what Mr. Livesey had said. In Scotland they had not yet reached so low as 16-candle gas; but he well remembered that some years ago, when the parliamentary standard was 25 candles, and he proposed that it should be reduced to 20 candles, he was opposed by nearly every gas engineer in the North—and he was not sure that some in the South did not also object; and it was with the greatest difficulty that they fought the question through Parliament. It was said that what would happen would be something terrible—the pipes would be too small, the consumption would go up some 25 per cent., the works would be inadequate, and generally the whole of the gas affairs in Glasgow were to be revolutionized. However, they reduced the quality from 25 to 20 candles; and the pipes were not too small, the accounts did not increase, and the complaints diminished enormously. There might be a difficulty in reducing from 16 candles to something less; but he certainly did think that making a rich quality of gas with a rapidly diminishing supply of the material for producing it, was not to the advantage of the consumers themselves.

Mr. S. Meunier (Stockport) said he thought the most important remark in the paper was: "A lower price rather than a higher quality is what consumers want." This was amply borne out by experience. Coal and oil had increased enormously, and other expenses had also gone up generally. Then, on the top of this, the gas consumer, especially the one who used gas for industrial purposes, had a further bill to pay. He (Mr. Meunier) did not know how far it would affect the southern districts; but in manufacturing towns, where large quantities of gas were used, and where they had industrial consumers paying from £500 to £1000 per annum for gas, it was a very material question. In the cotton-spinning industry, especially in the doubling and gassing departments, there was an enormous quantity of gas used; and he felt certain that a very much lower quality than that now supplied would be of far greater advantage to these consumers. The cost to them of an increase in price would be enormous; and if they could overcome the present need of a higher price by slightly reducing the illuminating power, it would not be only to the interest of the consumers but to that of the companies. He did not wish to say anything about the cost of carburetted water gas, but he should like to add one remark—that, although they might not appear in print, careful accounts were kept; and he had been surprised, in comparing notes with some of his friends, to find how closely they approximated. He quite confirmed the experience of the South Metropolitan Gas Company with regard to the poor burners generally used by consumers as being one of the main conditions incident to lowering the quality of gas. In his own town, they supplied 18½-candle gas; but the light afforded to many of the houses was nothing like what it ought to be. It was quite a common occurrence to have complaints, which they rather encouraged—not that the gas was bad, but that the light was bad; and almost invariably, when the burners had been attended to, they never had a recurrence of the complaint. He could not help thinking that the plumbers were very much to blame for simply putting on the first thing that came to hand. The cost of gas need not be so high, especially considering that they now had the incandescent mantle, that coal was not likely ever to be again so cheap as it had been, and in view of the difficulties they would have to contend with in the opposition of the electric light, which was rapidly improving.

Mr. W. R. Herring (Edinburgh) thought the members would all agree with the general principle propounded in the paper. Some months ago he was prepared to raise the question of reducing the illuminating power of his gas from 25 to 20 candles; but he had not then seen the current year's coal contracts. They revealed the startling fact that the difference between his supplying 15-candle gas, such as they obtained from the ordinary coal they used, and the present 25-candle gas only amounted to 3d. for the 10 candles. The ordinary coal cost 15s. 6d., and the average worked out to 18s. 6d. per ton. They were in a peculiar position, being near the cannel-fields. Cannel cost 28s. a ton; and he found from experience that the so-called 30-candle cannel gave an enriching value of about 40 candles. It was nonsense to suggest reducing the illuminating power under conditions like these. But where people were far away from the cannel-fields, no doubt they should be allowed to supply gas from the coal most suitable in the locality. He believed that if the money now spent upon testing-stations and experts were allotted to gas inspectors at £2 a week, to go about with their pockets full of gas-burners, it would do far more good to the public.

Mr. J. Stelfox (Belfast) said the author, with his usual ability, had been advocating the reduction of the illuminating power of gas; and probably he was quite right, from his point of view. But he (Mr. Stelfox) could not say that his experience agreed with Mr. Livesey's that the public were satisfied with lower-power gas.

Mr. Livesey remarked that the public did not ask for a lower-power gas; they wanted cheap gas. They did not know anything about the power.

Mr. Stelfox said they thought they did, and that was worse. When managers had to give 17 or 18 candle gas, it became a question which was the cheapest form of enrichment. He did not know why Mr. Livesey should suppose that coal was going to come down and oil to stop up; and he saw no reason to think that one would be more permanent in price than the other. At the present moment, the rise in the price of coal meant much more than the advance in the cost of oil. This was borne out by the fact that corporations and companies were almost weekly rushing in for water-gas plant in order to get rid of the coal difficulty. He was about equally interested in the two materials, and should be glad to see both come down to a normal figure. It was very awkward when one had to go from large contracts for oil at 2d. per gallon up to 3¼d., and in a few weeks to 4¾d., and in some cases higher. He believed, even to the London Gas Companies, 6s. or 7s. a ton in the price of coal would mean more than doubling the cost of oil. A remark had been made about the price being about equal for water gas and coal gas; but in these figures the water gas, as he understood, gave 4 or 5 candles more illuminating power than the coal gas, and therefore did not get as much credit as it should do. They were not now buying cannel, and were thus relieving the coal gas from an expense which would otherwise increase its cost.

Mr. S. Glover (St. Helens) said he could not agree with the principle of reducing the illuminating power of gas, though he thought it would be right to proportion it so as to enable gas companies to use to the best advantage the supply of coal in their own neighbourhood. He could not accept the statement that they were within a measurable distance of the time when non-luminous gas would be required, because he could not get over the fact that local authorities who supplied their own gas took blame to themselves when, from some mishap, they found they were not supplying the quality they were accustomed to. In London, the general practice of using bad burners perhaps required alteration; but it was a fact that consumers very commonly found out when the quality of gas was reduced, as gas engineers who represented corporations well knew. The author had almost ignored the present position of

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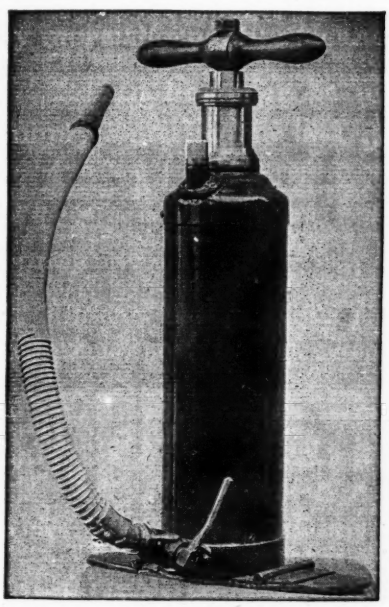

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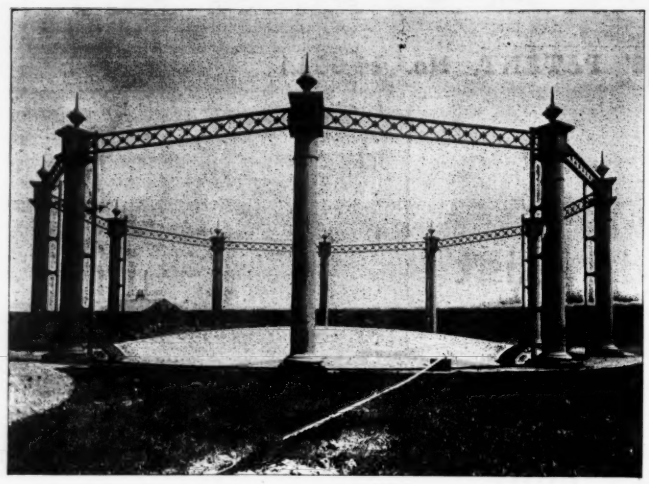

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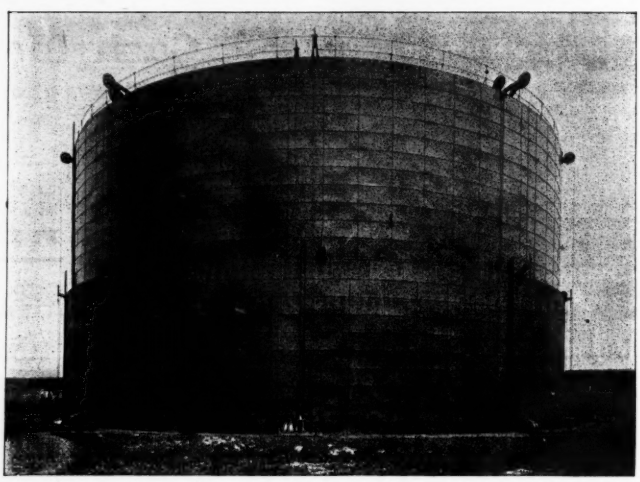

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benzol, because it did not support the argument about the desirability of doing away with enrichment, and also the possibility that when scientific men were faced with a difficulty they found other ways out of it than running away. The conditions regarding the use of cannel had been altogether altered by recent practice. There was no doubt benzol was being produced in very large quantities; and its present price was certainly lower than that of petroleum spirit. He was surprised to find they were asked to assume that there was no argument to be adduced to show that carburetted water gas was not permanent. The experience of Mr. Botley at Hastings was that, even when turning out his conglomeration of oil vapour and water gas, a certain scrubbing effect was going on in his mains, which prevented the need for so much oil being vaporized by his special apparatus. This proved, as it appeared to him (Mr. Glover), that carburetted water gas was not permanent. He did not think that enrichment to the proper point was useless to the consumer. He certainly agreed with Mr. Foulis's remark with regard to the results attained by different experimenters from incandescent gas-burners. It must be known to everybody of experience that the results which were obtained could be affected very largely by altering either the air supply or the gas supply; and he should conclude that in the German experiments the supply of the gas and air to the burner was not perfect, and even in the case of Mr. Carpenter's experiments with gas from 17 to 12 candles, probably the proportion of gas to air for the quality of gas used was not right for the particular burner. The heat-giving power of a flame must be useful when it was properly developed. There was one point which had been ignored perhaps too much in discussing this question, but he was always reminded of it when competition with the electric light was mentioned. If one did not maintain a supply of gas of good quality, the poorer gas had to be burnt in much larger quantity; and they were therefore turning into the rooms of the consumers very much greater quantities of the products of combustion, which they ought to try to prevent. Mr. Stelfox had referred to the difficulties he had experienced from the increase in the price of enrichers in proportion to that of the ordinary quality of coal which was employed to make the bulk of gas. But the consumers wanted good gas which would give them good illuminating power when used with proper burners; and they obtained greater efficiency from a smaller quantity of gas of high illuminating power than from a larger quantity of lower. In fact, there were many strong objections to reducing the illuminating power from that to which people were accustomed.

Mr. C. E. Botley (Hastings) said it had not been his intention to take any part in the discussion; but he could not allow the statement made by Mr. Glover to go unchallenged. He certainly had a "conglomeration" of ideas on this subject. If he (Mr. Botley) had claimed anything, it was that carburetted water gas should be made permanent; and in a discussion which took place some time ago with regard to another matter, he said it was quite possible to make it *un*permanent. They, however did not do this at Hastings. The various modes of enrichment, which unfortunately they had to employ, would depend on the circumstances of the particular locality. In the South they were differently placed from anyone in the North. Their general standard of illuminating power was 15 candles; and during last winter, owing to the difficulty of getting coal, he found the cheapest mode of enrichment was the use of cannel. Not having the coal, he was obliged to make more use of oil; and, in order to bring his gas up to the proper illuminating power, he had to enrich with cannel, and he found, to his astonishment, that it was cheaper than enriching it with carburetted water gas. He had been very pleased to listen to the paper. As usual, Mr. Livesey had struck out some new ideas. He (Mr. Botley) had thought many times that the old views of testing imposed upon them should not be maintained now that the monopoly no longer existed. They had great competitors, and why should they not be put in the same position as any other trader—that they should give the best they could to the public, and let the public judge? If they could get gas cheaper than the electric light, and as good, they would use it; if not, they would use the newer light. He thought possibly the time might be approaching when tests for illuminating power should not be enforced, but only those for purity.

Mr. F. D. Marshall (Copenhagen) said he might add one remark on the question of oil. To find the origin of the rise in price, he must go back to the blessed Peace Congress at the Hague. Ever since that, the world had never seen such preparations for armaments going on as they were witnessing at the present time; and the result was that there was a shortage of fuel all over the globe. Russian agents were going everywhere to obtain fuel, and could not get anything like the amount they wished for. America was also short. The boom in the steel trade was something enormous; and, as long as this was going on—and it seemed likely to continue for some years—there must be scarcity of fuel. The crude oil at one time was almost a waste product; and he remembered buying it at 2d. a gallon. But they would never see this price again, because Russia, who had really the largest supply, was putting a restriction on the export, and would continue to do so. She had been seeking to supply with coal her ports in the China Sea and her coal depôts, but was absolutely unable to do it; and Germany was trying to do the same thing. The coal supply failing them, they were having recourse to the natural product of their own country—oil; and he was afraid, in case of preparations for war in this country, the export of oil from Russia would be permanently stopped. They had America to fall back upon; but the boom in the steel trade in America was colossal, and the American engineers, finding the shortage of coal, were turning their attention to altering the flues of their furnaces so as to utilize oil. He believed the days of cheap oil had departed never to come back. He had coquetted with water gas for many years, but had never screwed up his courage to propose; and he did not think he should be able to do so now.

Mr. E. A. Harman (Huddersfield) said he could scarcely follow the argument of the author, that if the policy of pressing for higher illuminating power was continued, or even if the present standard was maintained, the cost of coal gas must permanently increase. It seemed to him that if they were to make poorer gas from inferior coal they would require a very much larger quantity of material; and therefore the demand for coal would be greater than if they were making a higher quality of gas.

Mr. Charles Hunt (Birmingham) said he did not agree with the last speaker on the coal question. The demand for a higher quality of gas meant a demand for a better class of coal; and as this was worked out, they were driven more and more to the inferior coal, which produced an equal quantity of gas of lower illuminating power. He quite agreed with the policy enunciated in the paper, as a measure of permanent economy—that enrichment should be avoided as far as practicable, and that gas should be supplied of the quality which could be derived from the coal generally in use without enrichment. They would shortly be told that the time was coming when gas would not be judged by its illuminating power, but by its heating properties; and he thought they ought to be prepared for this, even at the present time. The rapid strides which the incandescent system was making proved that the heating value of gas was what had to be considered; and there could be no question whatever that gas of lower illuminating power gave proportionately higher calorific value than rich gas. If, however, they were driven to use means of enrichment, he thought the least satisfactory was carburine—the light spirit derived from American petroleum. Some years ago, when they employed it rather largely, he frequently had samples brought to him, from the syphons in the vicinity of the works, showing that there was a deposit of hydrocarbons immediately beyond the works. He did not think this was the case with benzene; and he felt sure it was not with carburetted water gas. The difficulties which might be expected in the future with regard to the latter gas had been referred to; and this only showed that they must not pin their faith too much to any one thing. They heard last winter of a company's undertaking where carburetted water gas had been applied in the hope that it would save them from a coal famine; but they had an oil famine instead. Gas managers must therefore apply themselves to any form of enrichment or manufacture which might be presented to them, and use it as opportunity served and price allowed.

Mr. Livesey, in reply, said he must express himself as very pleased indeed with the discussion, and was glad there had been something said on both sides. What Mr. Foulis had stated about the supply of air to the incandescent burner was perfectly true; but the point he (Mr. Livesey)

made was that, taking the 16 or 16½ candle gas with which the consumer was supplied in London, or the 13-candle gas sent out in Germany, reducing the illuminating power with the burner the consumer used he obtained more light. The inference seemed to be that, with the burner as sold by the makers for use with these qualities of gas, the supply of air and gas was not properly adjusted, and that by reducing the luminosity of the gas they got a proper adjustment—at any rate, the consumer would benefit.

Mr. GLOVER asked by what means the illuminating power of the gas was reduced.

Mr. LIVESEY said he believed it was by passing it through heavy oils. At any rate, some of the hydrocarbons were taken out. Of course, they could not make gas of 10-candle power under the present arrangements. His point was that, with a lower quality of gas, with the ordinary burner, the consumer got a better light than he did with gas of the normal quality. He had read with great interest Mr. Herring's paper before the Royal Scottish Society of Arts, and there saw that he suggested a reduction in the illuminating power. He (Mr. Livesey) was in perfect accord with him. If any enrichment was necessary, they must use those means which enabled them to attain it most effectively and cheaply. Mr. Botley found last winter that cannel was cheaper than water gas, and used it; and Mr. Herring found cannel was relatively cheaper than common coal at the present price, but at the ordinary figure common coal would be much cheaper. Cannel had not gone up in price anything like proportionately with common coal; but if everybody were to use cannel for enrichment, things would be very different. The only reason why cannel had gone down somewhat from the figure of ten years ago was because carburine and other things had taken its place. With reference to non-luminous gas, he had been told by Mr. Webber, who had lately visited North Germany, that they were going strongly in that direction, and that 85 per cent. of the lighting was done by incandescent gas-burners. If they had 85 per cent. of the lighting and all who used gas for manufacturing purposes, and required only calorific value, high quality ought not to be kept up. The remaining 15 per cent. of the consumers would have to fall in line with the rest, who wanted gas as cheap as ever they could get it. Mr. Hunt said he thought benzol did carry; but gas would only carry a limited amount of benzol. The remark about carburetted water gas being estimated at 1d. per candle for each candle added was based on their own cost of coal gas. It all depended on the circumstances in which it was used. Enrichment was very troublesome and unnecessary; and it would be to the interest of the consumer to do away with it. What Mr. Marshall had said about the price of oil entirely confirmed the information he (Mr. Livesey) had been able to obtain. He had been in communication with large importers of oil, and they told him that the American supply was not sufficient, that it was falling off and that the demand was greater than ever, and that the Russian Government were increasingly using it as fuel; and his friend said he thought there was no probability of oil ever coming down to its old price. Now, he did not believe that coal would be permanently higher; he thought the time would come when there would be a depression in trade. He was informed about a month ago, by an official connected with the iron trade, that they had passed the summit. Meeting him again a few weeks after, and asking him if he still held the same opinion, he said he did, emphatically. Then he (Mr. Livesey) put another question: "Would the American supply of iron come in?" His friend said he wished he could answer that inquiry; but his emphatic opinion—and he was a man who knew as much about the iron trade as anyone—was that the trade had passed the summit. He (Mr. Livesey) therefore quite thought they might expect a reduction in the price of coal within a reasonable period.

THE CALORIFIC POWER OF ILLUMINATING GAS.

By HAROLD G. COLMAN.

In the earlier days of gas lighting, when the gas was used almost entirely for illuminating purposes, the physical property which was of the first importance was its illuminating power; and endeavours were continuously made to determine this with as high a degree of accuracy as possible. At the present time, however, a very large and constantly increasing proportion of the gas output is employed for purposes in which calorific power is of greater importance than illuminating power; and the importance of an accurate knowledge of the former has therefore greatly increased. It is, indeed, quite possible that before long the calorific power of the gas supply may become of even greater importance than its illuminating power. Until comparatively recently, no simple and rapid method of directly determining the former has been available, although the calorific power of various gases, including coal gas, has been ascertained by several scientific investigators, including Favre and Silbermann, Berthelot, and Stohmann. The apparatus then employed was not, however, suitable for technical purposes, although a modification of Berthelot's calorimeter, devised by M. Mahler, has been employed in France, by M. Aguitton,* who examined the calorific power of gas, the illuminating power of which varied from 5 to 15 candles. In most cases where it has been desired to estimate the calorific power, this has been done by making a complete analysis of the gas, and calculating the calorific power of the gas from that of its constituents. This method is far from satisfactory, as not only is the making of a complete analysis of the gas a tedious process, but it is not easy to get accurate values for those constituents which have to be determined by explosion. Further, no means are known of determining the exact composition of the hydrocarbons absorbed by bromine or fuming sulphuric acid; and as these have, for equal volumes, the highest calorific value of any of the constituents, a considerable error is possible in the calculated value.

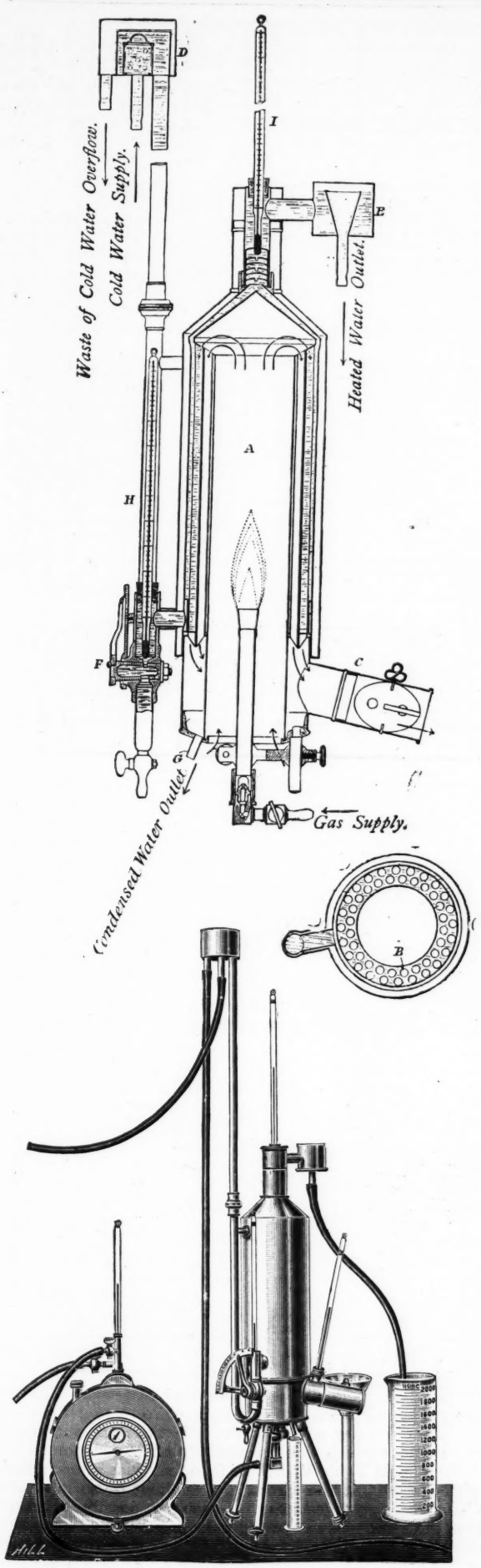
About ten years ago a new calorimeter was devised by Herr Junkers, of Dessau, which, from the published description, appeared likely to afford a quick and accurate method of ascertaining the calorific power of gases. After several years' experience, the author finds that the instrument does satisfactorily accomplish this end; the time required to complete a test being about the same as for an illuminating power test with candles. As the instrument may not be familiar to everyone present, a description of its construction and method of working is here given.

The principle on which the apparatus acts is that the heat generated by the flame of the burning gas is transmitted to a current of water flowing at a constant rate; and measurements are made of (1) the quantity of gas burned, (2) the quantity of water passed through the apparatus, (3) the difference in the temperature of the water on entering and leaving the apparatus, and (4) the amount of water condensed from the products of combustion. The construction of the apparatus will be readily seen from the accompanying illustrations. The flame of burning gas is introduced into a combustion chamber formed by an annular copper vessel A; the annular space being traversed by a considerable number of copper tubes B, connecting the roof with the bottom of the chamber. The products of combustion pass through these tubes in a downward direction; while the water current passes outside them in the opposite direction. The waste gases are thus completely cooled to the temperature of the water, and pass through the side-conduit C into the atmosphere. The water which condenses from the products of combustion falls to the bottom of the apparatus, and thence through the small tube H into a measuring glass.

The pressure of water is kept constant by means of the two overflows D and E; the water being run into the upper one D, at a greater rate than it passes through the calorimeter, the excess running to waste through the overflow-pipe. Similarly, the water on leaving the apparatus has to pass over the top of the funnel in E; thus maintaining a constant head of water, resulting in a uniform flow of the liquid through the apparatus. The rate of flow is regulated by the cock F. Before entering the calorimeter, the water passes over the bulb of the inlet thermometer H; and after traversing the annular chamber, flows through a series of baffle-plates to ensure thorough mixing before it reaches the thermometer I. Thence it reaches the overflow E, and is collected and measured. To prevent radiation, the whole body of the instrument is enclosed in an air-jacket formed by a polished or plated copper cylinder.

In making a test, the water is first turned on, and when it is running from both overflows, the gas is lighted and

* See "Comptes Rendus," CXVII., p. 56; also "JOURNAL," Vol. LXII., pp. 355, 402.



JUNKER'S CALORIMETER.

burnt at a rate of 4 to 8 feet per hour, and the speed of the water regulated by the cock F; so that the difference in temperature between the inlet and outlet thermometers is 10° to 20° C. As soon as the difference is nearly constant, and the condensed water is dripping regularly from the pipe G, the test may be commenced. This is done by waiting till the gas-meter index passes any particular point (which is noted down), and then quickly introducing the outlet water-tube into the measuring vessel, and placing a measuring cylinder under the condensed water outlet. Readings of the inlet and outlet thermometers are then frequently taken. The author's practice is to read the former every minute, and the latter every half-minute, and to continue the test until about 1 cubic foot of gas has passed; a measuring vessel being chosen for the water which holds the requisite amount. As soon as this is filled to a fixed mark, the gas is shut off and the measuring cylinder removed from the condensed water-pipe.

The calculations are extremely simple. The unit taken is the larger calorie, which is the amount of heat required to raise a kilogramme of water 1° C., and the results are calculated to the number of calories yielded by the combustion of 1 cubic foot of gas. The calorific power is therefore found by the equation:—

$$\left.\begin{matrix}\text{Cal. power of}\\ \text{1 cubic foot}\end{matrix}\right\} = \frac{\text{vol. of water in litres} \times \text{diff. in temp.}}{\text{gas consumed.}}$$

Taking a particular example, the following figures were obtained:

Temperature of gas, 62°; barometer, 29·8; water used, 8·0 litres; gas consumed, 0·935 cubic foot = 0·924 at 60° and 30-inch barometer; condensed water, 21 cc.

Therefore the gross calorific power

$$= \frac{8{\cdot}0 \times 18{\cdot}3}{0{\cdot}924} = 158{\cdot}4 \text{ calories per cubic foot.}$$

This, therefore, is the calorific power of the gas when the water formed by the combustion is converted into the liquid state in the calorimeter. In the condensation of the aqueous vapour, the whole of the latent heat of the latter is given to the water flowing through the instrument, and this is therefore included in the gross value. As, however, this latent heat of the aqueous vapour is scarcely ever utilized in industrial processes, it is necessary, in order to obtain the true calorific power with all the water formed escaping as steam, to deduct from the gross value an amount corresponding to the quantity of condensed water. Each cubic centimetre of condensed water has evolved a quantity of heat which may, for most purposes, be taken with sufficient accuracy as 0·6 calorie; and therefore this number multiplied by the number of cubic centimetres of water condensed, and divided by the gas consumed, gives the amount which must be deducted from the gross value to obtain the calorific power with the steam remaining in the gaseous state, usually termed the net calorific power. Thus, in the above example, 21 cc. of water were condensed, and the quantity to be deducted is—

$$\frac{0{\cdot}6 \times 21}{0{\cdot}924} = 13{\cdot}6 \text{ calories;}$$

making the net calorific value 158·4 − 13·6 = 144·8 calories. If it is desired to express the results in British thermal units, the number of calories must be multiplied by 3·97.

From the point of view of testing, the determination of the calorific power is much more satisfactory than that of illuminating power. In the latter case, in spite of all improvements, an absolutely accurate and constant standard of light has yet to be discovered; and, further, the illuminating power of the same gas varies according to the construction of the burner employed and the rate at which the gas is burned. The measure of the calorific power is the number of degrees by which the temperature of a certain weight of water is raised; and both of these can be ascertained with very great accuracy. The calorific power is also independent of the burner and rate of burning, so long as combustion is complete. Moreover, the unavoidable personal error is much greater in determining the equality of light of two illuminated surfaces than in reading off the height of a thermometer, or in measuring the volume or weight of water used. Photometrical observations are considerably affected by atmospheric conditions; but these have hardly any effect on the net calorific value, as determined by the calorimeter, although an error of 1 per cent. or so may be made in the determina-

tion of the gross value, if the atmosphere be exceptionally dry.

In the tables given in the appendix will be found a number of results obtained with the instrument, together with the illuminating power of the gas examined; the chief object of the investigation being to determine the manner in which the calorific power of gas corresponds with the illuminating power. The first column in Tables I. to IV. gives the illuminating power, determined with the Methven screen, and the second and third the gross and net calorific power. The number of calories (gross and net) corresponding to each candle of illuminating power are given in the fourth and fifth columns, and show the variation in the calorific power for the same illuminating power. For convenience, these figures giving the calories per candle may be described as the "calorific" ratio.

Table Ia. gives the results of a month's test of the gas sent out from one works. It will be seen that, for the same illuminating power, the gross and net calorific ratio varies to the extent of about 11 per cent. This variation is rendered very evident if the results are plotted into a curve; the curves for the gross and net ratios being, as would be expected, of a very similar character. The tests here given are only a small portion of those which have been made; but these all show very similar results, and the average of all tests of coal gas, which is given at the bottom of the table, very nearly agrees with the average of those given in detail.

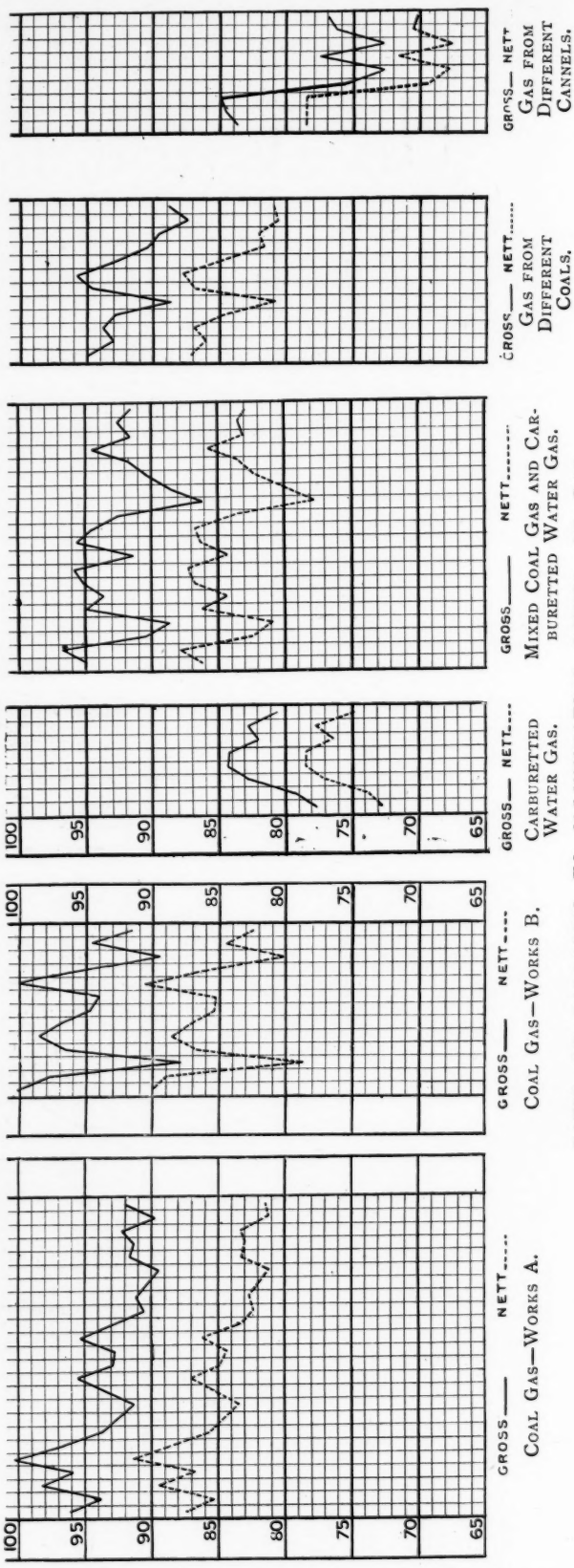
Table Ib. gives the results with the coal gas supplied from a second works, using different coals. The average calorific ratio is distinctly higher than in the first case; but the variation is rather greater—viz., 12 per cent. in the gross and 13 per cent. in the net value. Here also the curves for the net and gross ratios are of a similar character.

In Table II. will be found the tests of the illuminating and calorific powers of the gas from a number of different coals and cannels; these being tabulated in order of their illuminating power. The average value of the gross calorific ratio in the case of the coal gases is rather lower than that shown in Table I., while that of the net ratio is almost the same. It will be noticed that, in the case of gases having an illuminating power of about 18 candles, the calorific ratio has a falling tendency, which is very much more marked when we come to cannel gases having an illuminating power of 22 to 33 candles; these showing, on the average, 11 per cent. gross and 14·5 per cent. net less calorific power than the coal gases. Between the cannel gas showing the lowest ratio and the coal gas showing the highest, there is a difference of no less than 24 per cent. gross and 23 per cent. net.

The above results are not in agreement with those of M. Aguitton, which have been already referred to. He examined the illuminating and calorific power of gases varying in quality from 5 to 15 candles, and found that the calorific ratio was almost constant. Possibly this may be the case with gas of low quality; but it certainly is not true of gas having an illuminating power of 17 candles upwards.

Turning from coal gas, Table III. contains a few results obtained with carburetted water gas, the quality of which was in most cases from 16·5 to 18 candles. As this gas gives less water on combustion than coal gas of equal illuminating power, the difference between the gross and net values is less—viz., 7 per cent. instead of 9 per cent. It is usually stated that carburetted water gas has about 5 per cent. less calorific power than coal gas of the same illuminating power. But from these results, it would appear that, for the above quality, 10 per cent. is more nearly correct. The same variations in the calorific ratio are evident as in the case of coal gas. It may also be pointed out that the average gross calorific ratio is almost identical with the average of the same figure for the cannel gases; while the net figure is nearly 6 per cent. higher.

In Table IV. will be found the figures for a mixture of coal gas with a quantity of carburetted water gas, varying from 10 to 20 per cent. These differ very little from the corresponding coal-gas tests, although, calculated from the figures given above for the two gases separately, the calorific power should have been about 2 calories lower for 17-candle gas. It was not possible to take the calorific power of the coal gas at the same time; and it is probable that the calorific ratio of this was rather higher than when the above coal-gas tests were made, which compensated



RATIO OF CALORIFIC TO ILLUMINATING POWER OF GAS.

for the lower ratio of the carburetted water gas. In any case, it appears that the admixture of 10 to 20 per cent. of carburetted water gas does not affect the calorific power to an extent which would materially affect consumers.

Finally, in Table V. will be found a series of tests made with coal gas at the works, and an hour or so later at a distance of two miles away. It was not possible to ensure that the same gas was tested in both cases, and hence the daily tests show considerable variation; the calorific power at the works being sometimes greater and sometimes less than in the district. The average result is, however, nearly the same at both places; showing that there was

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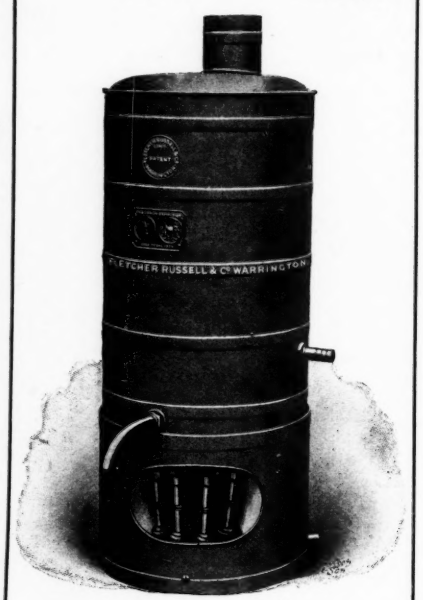

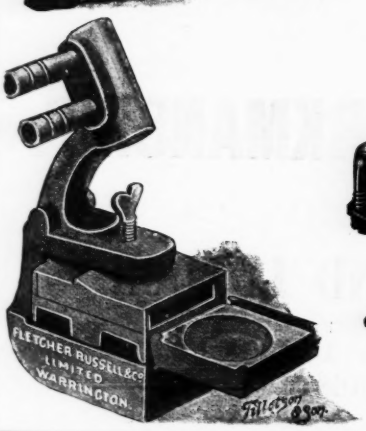

no appreciable falling off in the calorific power of the gas through traversing the main. It may reasonably be concluded that if there was no falling off in the calorific power, there was little or none in the illuminating power; as the illuminating hydrocarbons are those which have the greatest effect on the calorific power, and any diminution in their quantity would appreciably lower the latter value. In fact, for the reasons already given, the author believes that, for the purpose of comparing the quality of the gas in the works and in the district, the calorimeter is a far more satisfactory instrument than the photometer, portable or otherwise.

It must be borne in mind that although the calorific power is the most important factor in determining the relative value of a gas for heating purposes, there are other factors which have considerable influence. Thus, for example, in the case of incandescent burners, and of open gas-fires which effect the heating of a room in part by radiant heat, the temperature of the flame is of great importance. This is very much influenced by the construction of the burner, which is, however, a matter hardly falling within the scope of the present paper. Assuming a thoroughly efficient burner, the temperature of the flame depends very considerably on the relative volume of air required for its complete combustion, as well as on the calorific power. The smaller the amount of air required, the less will be the quantity of nitrogen whose temperature has to be raised, and the higher the resulting temperature for the same calorific power. Thus, uncarburetted water gas has a calorific power of only about two-fifths that of coal gas of 16-candle power; but as it only requires about 2·5 volumes of air for its complete combustion, the temperature of the flame is very high. Although the author cannot yet quote any actual experiments on the subject, there is but little doubt that the illuminating power of water gas in an incandescent burner would be decidedly higher than two-fifths that of 16-candle coal gas.

With gas-engines, matters are rather different. The efficiency of the gas depends upon the pressure caused by the explosion, which is determined in part by the calorific power of the gas, the composition of the gases remaining after the explosion—viz., steam, carbonic acid, nitrogen, and oxygen—and their specific heats. It is at present impossible to calculate from these data any reliable figures, as so little is yet known of the specific heat of gases at temperatures anywhere near those of combustion; and for this reason, among others, temperatures of combustion or of pressure caused by explosion calculated from the calorific power of a gas, and the relative quantities and specific heats of its products of combustion, are quite fallacious—the figures being generally more than double the highest ever experimentally obtained.

Until more light is thrown on this subject, therefore, the calorific power of a gas is the only property of a gas which can be experimentally determined to judge of its relative efficiency in gas-engines; but it should always be remembered that there are other factors whose relative amount it is not yet possible to ascertain.

Discussion.

The PRESIDENT said there was no doubt the subject before the meeting was one of very great and growing importance. It was fortunate that the paper came after the one previously read, because the two ran on very similar lines; and the statement Dr. Colman had made, that the future of coal gas would rest as much on its calorific as on its illuminating power was one which required a great deal of attention.

Mr. CHARLES HUNT (Birmingham) said the paper might be regarded as a sign of the stage at which they had arrived in the development of the uses of coal gas; and their thanks were due to Dr. Colman for having brought forward his interesting series of experiments. The object he had in view had been to establish, if possible, a kind of ratio between the calorific value of gas and its illuminating power; but, seeing that there was a difference of about 10 per cent. in the experiments, he was afraid he had not arrived at a very satisfactory result. It appeared, moreover, that as the heating property of gas varied according to the illuminating power, the calorific value of different gases must be ascertained for each—15, 16, or 17 candle gas must be taken by itself. But there was another point of view from which these experiments were

APPENDIX.

TABLE IA.—*Illuminating and Calorific Power of Coal Gas (Works A).*

Illuminating Power.	Gross Calorific Power.	Net Calorific Power.	Calories per Candle Gross.	Calories per Candle Net.
17·24	165·6	150·8	9·61	8·74
17·16	160·9	146·2	9·38	8·52
16·47	161·9	147·2	9·83	8·94
17·15	164·4	148·7	9·59	8·67
16·34	164·0	149·4	10·03	9·14
17·17	165·8	151·2	9·66	8·80
17·64	165·3	151·3	9·37	8·57
17·41	161·3	147·1	9·26	8·45
17·56	160·4	146·6	9·13	8·35
17·34	161·0	147·3	9·28	8·49
17·51	167·2	152·3	9·55	8·70
17·34	161·1	147·0	9·29	8·48
17·60	163·3	148·4	9·28	8·43
17·26	164·4	148·5	9·53	8·61
17·42	161·8	144·9	9·29	8·32
17·17	155·6	141·3	9·06	8·23
17·28	157·4	142·8	9·11	8·26
17·38	157·0	142·3	9·03	8·19
17·22	154·1	139·9	8·95	8·12
17·10	156·9	142·1	9·17	8·31
17·46	159·7	144·9	9·15	8·30
17·30	159·5	144·2	9·22	8·34
18·00	161·4	146·3	8·97	8·13
17·47	160·7	142·2	9·20	8·14
Average				
17·29	161·3	146·4	9·33	8·47
Average of all coal-gas tests made at Works A.				
17·33	160·0	145·6	9·23	8·40

TABLE IB.—*Illuminating and Calorific Power of Coal Gas (Works B).*

Illuminating Power.	Gross Calorific Power.	Net Calorific Power.	Calories per Candle Gross.	Calories per Candle Net.
16·24	162·8	146·2	10·02	9·00
16·36	160·1	145·6	9·79	8·90
17·12	150·4	134·8	8·79	7·87
16·56	160·1	143·4	9·66	8·66
16·42	162·0	145·3	9·86	8·85
16·46	159·7	143·3	9·70	8·71
16·57	157·1	141·5	9·48	8·54
16·76	157·7	142·8	9·41	8·52
16·11	160·9	146·1	9·99	9·07
16·42	157·1	141·6	9·57	8·62
17·50	156·3	140·2	8·93	8·01
16·72	158·1	141·2	9·46	8·45
17·14	156·9	141·3	9·15	8·24
Average				
16·65	158·4	142·6	9·51	8·56

TABLE II.—*Illuminating and Calorific Power of Gas from Various Kinds of Coal and Cannel.*

Illuminating Power.	Gross Calorific Power.	Net Calorific Power.	Calories per Candle Gross.	Calories per Candle Net.
Coal Gas.				
16·04	152·2	139·7	9·49	8·71
16·75	156·4	144·2	9·30	8·61
16·92	158·8	147·1	9·38	8·69
16·98	157·8	144·2	9·29	8·49
17·14	152·0	138·6	8·87	8·09
17·22	163·1	149·7	9·47	8·69
17·25	165·0	151·4	9·57	8·78
17·42	161·8	148·1	9·29	8·50
17·82	161·1	145·6	9·04	8·17
17·93	159·8	147·2	8·90	8·20
18·00	157·4	145·3	8·74	8·07
18·20	161·7	147·3	8·88	8·09
Average				
17·31	158·9	145·7	9·18	8·42
Cannel Gas.				
22·89	191·9	179·6	8·38	7·85
23·80	201·3	186·8	8·46	7·85
25·04	212·6	196·5	8·49	7·85
29·30	221·1	203·4	7·55	6·94
29·46	214·0	199·7	7·26	6·78
31·24	242·0	223·2	7·75	7·15
31·51	229·0	212·9	7·27	6·76
31·80	241·8	224·2	7·61	7·05
33·30	255·8	233·9	7·68	7·02
Average				
28·70	234·4	206·7	8·17	7·20

TABLE III.—*Illuminating and Calorific Power of Carburetted Water Gas.*

Illuminating Power.	Gross Calorific Power.	Net Calorific Power.	Calories per Candle Gross.	Calories per Candle Net.
17·96	139·6	130·7	7·77	7·28
18·03	142·8	133·0	7·93	7·38
17·49	144·6	134·8	8·27	7·71
16·66	140·5	130·7	8·43	7·85
16·80	141·4	131·8	8·42	7·85
16·94	138·9	129·4	8·20	7·64
16·88	139·7	131·3	8·28	7·78
18·93	152·6	141·7	8·06	7·49
Average				
17·46	142·5	132·9	8·15	7·61

TABLE IV.—*Illuminating and Calorific Power of Mixed Coal Gas and Carburetted Water Gas.*

Illuminating Power.	Gross Calorific Power.	Net Calorific Power.	Calories per Candle Gross.	Calories per Candle Net.
17·08	162·3	147·3	9·50	8·62
17·02	164·8	149·6	9·68	8·79
17·48	159·7	144·0	9·14	8·24
17·75	157·3	143·7	8·86	8·10
16·61	157·6	143·1	9·49	8·61
17·00	159·3	142·6	9·37	8·54
16·68	158·6	144·8	9·51	8·68
16·66	159·6	145·2	9·58	8·72
17·17	158·5	144·8	9·23	8·43
16·73	159·9	144·3	9·56	8·63
17·08	161·4	148·1	9·45	8·67
17·00	157·5	142·3	9·26	8·37
17·07	147·0	132·7	8·61	7·78
16·93	149·9	135·4	8·85	8·00
17·56	158·3	144·2	9·02	8·21
17·33	159·0	144·4	9·17	8·33
17·29	163·3	148·2	9·45	8·57
17·07	156·5	141·9	9·17	8·31
17·09	158·0	142·7	9·25	8·35
17·32	158·8	143·8	9·17	8·30
Average				
17·09	158·4	143·6	9·27	8·40

TABLE V.—*Calorific Power of Gas at the Works and at a Distance of Two Miles Away.*

At Works.		Two Miles Away.		Difference.	
Gross Calorific Power.	Net Calorific Power.	Gross Calorific Power.	Net Calorific Power.	Gross.	Net.
166·9	151·8	169·3	154·3	+ 2·4	+ 2·5
162·4	147·6	158·3	146·1	− 4·1	− 1·5
155·4	138·9	163·3	149·2	+ 7·9	+10·3
156·8	141·3	155·0	140·9	− 1·8	+− 0·4
159·4	143·8	163·1	148·7	+ 3·7	+ 4·9
160·2	146·1	158·1	144·9	− 2·1	− 1·2
157·8	138·0	155·5	142·0	− 2·3	+ 4·0
159·4	144·2	152·6	139·8	− 6·8	− 4·4
157·9	142·1	159·8	146·2	+ 1·9	+ 4·1
158·8	144·9	152·4	140·6	− 6·4	− 4·3
159·3	144·1	161·0	146·8	+ 1·7	+ 2·7
163·0	147·7	155·4	141·4	− 7·6	− 6·3
Average					
159·7	144·2	158·7	145·1	− 1·0	+ 0·9

interesting, and that was the light they threw on the value for heating purposes of gases of low illuminating power. He was sorry the author had not been able to extend his experiments to 14 or 15 candle gas; but so far as they went they were extremely interesting. One curious feature about them was this: He noticed that in the first table the two gases of lowest light-giving value—16·47 and 16·34 candles—gave the highest number of calories per candle; and the gas of the highest value (18 candles) gave almost the lowest. Turning to Table 1B, the difference was more marked. The three gases lowest in illuminating power gave absolutely the highest value for heating purposes, and the three highest in illuminating power were absolutely the lowest in calorific value. There was only one conclusion to be drawn—that the heating value of gas of low illuminating power was greater in proportion than that of high-power gas. This was not the first time this had been pointed out. The late Dr. Wallace many years ago published experiments showing the great falling off in the heating value of cannel gas; and some trials which he (Mr. Hunt) made in 1882, in connection with a gas-engine, had proved the same thing, and also that gases down to 12-candle power were of greater proportionate value for heating purposes than those of 15 or 17 candles, although the difference was not so marked as would appear from the tables. He assumed that Table V. was for the purpose of checking the accuracy of the illuminating power tests. Knowing the conditions under which the tests were made, he might say that these were taken in order to verify or otherwise the accuracy of the illuminating power tests, which did not accord with those taken at the works. A considerable falling off was experienced at the testing-station in the town; and in order to trace it, if possible, these tests were made. Those taken for the heating value showed the gas to be practically identical; and the only inference to be drawn was that the tests for illuminating power varied, on account of the conditions under which they were carried out. This showed that, in order to make accurate tests, the conditions must be absolutely reproduced at every point, or else they were not reliable. He might say further that since the room in which the tests were taken had been abandoned in favour of another built under more modern conditions, the discrepancy no longer appeared.

Mr. F. D. MARSHALL (Copenhagen) remarked that in his address last year he had said he believed that in future the calorimeter would play a greater part in the daily testing of gas than the photometer itself; and he was every day more convinced that this would be so. He had for the last five years—in fact, ever since the instrument was made—been using it daily in conjunction with the photometer, because he believed these two instruments should always be employed together; and they found that in many ways it had been a great help, because they had been able to check what was called the "personal error." It was now recognized that, however beautiful the photometer might be, and however carefully it was used, one could not avoid this personal error. But with the little instrument before them, the error was reduced to the minimum. It was so simple that a child could work it; and it was astonishing that so few were used in English laboratories. Dr. Colman had only given the range of gases between 17 and 22 candles; but he (Mr. Marshall) was able to present a larger range—viz., from 18 down to 12 candles, although he had not had time to work all the figures through. He would, however, give the salient points. Dr. Colman had worked out his calories at per cubic foot. On the Continent, they worked them out per cubic metre; and he must express his regret, seeing that the instrument was based on the metric system, that this had not been followed out in the calculations. For 18-candle gas, Dr. Colman gave a net value of 146 calories. Their experiments showed a slightly higher result—viz., 150 calories; so that there must have been a large amount of personal error in the reading of the photometer. For 17½-candle gas, Dr. Colman's figure was 151; and theirs, as the result of some thousands of experiments, 148—again showing a considerable personal error. For 16-candle gas, Dr. Colman's figure was 146, and their experiments 147. Coming to gas of lower quality, there was the remarkable result that for 13 candles he obtained 135, and for 12 candles 137 calories. If they took a higher quality gas—say, 18-candle—they only had 8 calories per candle; but with 12-candle gas it was 11 calories. It seemed to him that this amplified much which Mr. Livesey had been trying to convey to them—that the lower they went in illuminating power the greater efficiency they obtained in the calories developed per cubic foot of gas consumed. If they could communicate these facts to the gentlemen sitting not very far off, it might possibly have some good results. The calorific value of gas would play an important part in the future, especially to the users and makers of gas-engines. He was constantly receiving forms to fill up, stating the calorific value of the gas in different towns of which he had cognizance, because manufacturers of gas-engines said they had to make their machines to suit the value of the gas to be employed. Formerly, they used to return the illuminating power; but the engine makers said this was not of much value—they wanted the calorific power. He thought the day would soon be past when they pinned their faith to the photometer; and when that fetish was destroyed, they would be able to supply the quality of gas really most useful.

Mr. D. H. HELPS (Redhill) asked if it were not possible to have two gases, each of 15-candle power, but of totally different composition; and, if so, would it follow that their calorific value would be the same?

Mr. FORBES CARPENTER said the paper before them was one of special interest, and he should like to ask whether, with high illuminating powers, such as those described in

the second table, they could ensure the perfect combustion of the gas. One could understand an instrument being made with absolute scientific accuracy and skill; and yet with gas of high illuminating power the combustion chamber might not be large enough to get into play the full effect in calories. The point shown by Table II. was most important, and emphasized what experience he had had. He had seen the instrument in operation at very large works (not gas-works) in the North; and they would not be without it on any account. It was an establishment where producer gas was in extensive use; and with the instrument they found they were able to keep a complete check on the operations which had to be performed. With the increasing use of gas-engines and producer gas, it might be said that gas of lower illuminating power would lend itself better to the gas engineer, on account of the greater compression of the load when gas of this kind was used; and the liquid hydrocarbons did not separate and tend to decompose in the valves. On a former occasion, Mr. Livesey had said something about the difference between illuminating power and illuminating effect; and in listening to this paper the same idea occurred to him—that there was a difference between calorific power as ascertained by such an instrument as the one before them, and calorific effect when the flame was burnt for heating purposes in a room, depending very largely on the size of the flame for its radiant effect.

Mr. W. King (Liverpool) remarked that about five years ago he was much interested in this question, and also in the instrument exhibited; and so he requested Mr. Leicester Greville to undertake some experiments for him with it. The figures handed to him by Mr. Greville as the result were as follows: With London gas, 15·6 candles (he presumed it was tested in the argand burner under ordinary conditions), the British thermal units yielded were 641; while 16-candle gas of the same description gave 653 units. They then tried a gas of 20·1 candles; and the result was 706 units. Carburetted water gas of 20-candle power was also tried (in these two cases the illuminating power was ascertained at a consumption of 5 cubic feet per hour in a batswing burner); and the result obtained was 627 units.

The President asked if these figures were gross or net.

Mr. King said they were the gross figures—the condensed water not being allowed for.

Mr. E. A. Harman (Huddersfield) said it seemed to him that one of their long-established convictions was being knocked on the head—viz., that the illuminating power of the gas at a distance from the works was somewhat less than it was at the works; but, according to Table V., the tests made two miles away did not show any diminution in quality, because it was argued that, as there was no falling off in calorific power, there was little or none in illuminating power. But Mr. Marshall's figures proved that this hardly held good, inasmuch as the calorific power of higher and lower grade gases varied so strangely. Mr. Hunt had also used the same argument—that there was no falling off in the quality of the gas at a distance of two miles; whereas they usually admitted that there was a diminution, which was generally reckoned at about a quarter of a candle per mile. With regard to the last two paragraphs of the paper, they seemed to cancel one another. Dr. Colman said it was at present impossible to calculate, from the data he had before him, anything at all reliable respecting gas for use in gas-engines; but in the next paragraph he stated that the calorific power of gas was the only property which could be experimentally determined, to judge of its relative efficiency. It would be generally conceded by the users of gas-engines that the better the illuminating power of the gas, the easier it was to work an engine. He had had in his own experience an instance in which they had considerable difficulty in starting an engine; and, having set it going, much greater difficulty in keeping it running. Every kind of experiment was tried to see what was the matter; and it was eventually found that in a small holder there was a quantity of "church gas"—made on a Sunday night, after the retorts had been standing all day—and this gas of low illuminating power was quite unable to do anything with the engine. Having changed the holder, and put on 17 instead of 15 candle gas, they had no difficulty whatever.

Mr. F. D. Marshall (Copenhagen) said the case mentioned by the last speaker was an instance of an engine being adjusted to a higher quality of gas. According to his experience, the lower-quality gas was the better. The engine ran longer with 14 or 16 candle gas, there was no wearing of the valves, and no deposit. In fact, manufacturers had told him they would rather supply gas-engines to towns using gas of low quality than to Scotland. Some time ago, they had from Scotland two of Clerk's engines, which turned out to be failures. They had run very well in Scotland; but he could not get any work out of them, and ultimately converted them into steam-engines.

The President said the paper was especially important, and one which seemed likely to upset many preconceived ideas; but he could not help thinking that most of the speakers, in remarking on the question of the increased calorific power per candle of the gas, according as the quality decreased, had in their minds what had been described as the "personal error." Mr. Marshall and several other speakers said it was particularly difficult to avoid this error in dealing with the illuminating power of gas. They, however, stated that the beautiful instrument before them was absolutely incapable of making a mistake. Mr. Douglas Helps had asked a very pertinent question—whether it was not possible to have two gases identical with regard to illuminating power, but of very different constitution; and whether these gases would be of the same calorific power. It seemed to him (the President) to be quite possible that the reason for the differences which had been noticed might arise in two ways. One might be that the constituents which were in, or were added to, gas of high illuminating power might not be so high in calorific power as the constituents which went to make up gas of lower illuminating power. This would be proved to a certain extent by the fact that Dr. Colman showed that a gas lost in illuminating power in travelling several miles. Was it not possible that in its course certain of its constituents had dropped out, which, while reducing the illuminating power, did not affect very much its calorific value? Again, he could not help thinking that there might possibly be a great deal of truth in what Mr. Forbes Carpenter said, that Junkers calorimeter might not always be suitable for gases of varying illuminating power.

Dr. Colman, in reply, said, with regard to the question raised by Mr. Hunt and Mr. Marshall, as to the calorific ratios of gases of less than 16-candle power, he was sorry to be unable to give them, simply because he had not had the opportunity of submitting such gases to a test. He had been obliged to test what gases he had come across; and he had given the results. It was quite true that, generally speaking, even within the limits of 16 or 18 candles, there was a prevalent tendency for the calorific ratio to become higher as the illuminating power decreased. It appeared, from Mr. Marshall's statistics, that, as the quality went lower, this was much more marked; and, finally, at 12 candles they had a calorific ratio of 11 instead of something like 8 or 9. With regard to the question of variations, the daily changes in the calorific ratio might, under unfavourable circumstances, rise to as much as 10 per cent.; but it was quite true that the whole of the errors of observation, whether of the calorimeter or the photometer, were dealt with. He had indicated his belief that the errors were far greater with the photometer than with the calorimeter, and any errors of the former instrument tending to bring the gas out higher or lower would tend also to exaggerate the daily variation. With regard to the question put by Mr. Douglas Helps, as to gases having similar illuminating power with different compositions, he should say they would not have the same calorific power, and that this was the cause of the variations found—that, although the illuminating power might have been something like the same, the composition of the gas was very different. In fact, if daily tests were made of the hydrocarbons present in gas which were absorbable by bromine—chiefly ethylene and benzol—it would be found that the amount varied exceedingly, though the quality of the gas might not vary more than half a candle. With their own gas, the percentage of hydrocarbons absorbable by bromine varied from 3·5 to 4·5, and even more. Nothing in regard to illuminating power could be deduced from analysis, because the hydrocarbons which had the greatest effect—ethylene and benzol—had to be determined together; and one had no means of determining their relative proportions. Benzol had much greater effect on the illuminating than on the calorific power of gas. This brought him to another point in connection with the apparent drop in the illuminating power. Assuming that it had dropped between the works and the district, if gas was carrying

along with it suspended particles of hydrocarbons which were condensed in liquid form, they might drop out as the gas passed along; but after being subjected to filtration in the purifiers, the amount of this could not be very great. However, he knew of no determinations on this subject. If there was a drop of the substances actually present as vapour in the gas, the one specially likely to be condensed was, of course, benzol. Ethylene was a gas at a temperature far below the freezing-point, and there was no fear of any of it falling out; so that any drop of illuminating power not due to mechanically carried particles must be due to a diminution in the amount of benzol vapour. In connection with the experiments at a distance of 2 miles, they were undertaken because the illuminating power tests were not coming out at all satisfactorily, in spite of the fact that, to all appearance, the gas was the same. The height of the flame in the argand burner was exactly the same as at the works, nevertheless it was coming out two or three candles lower. These experiments with the calorimeter were made to determine whether there was any drop in the calorific power of the gas; and they showed that there was none. The point he wished to raise was rather different from that which Mr. Helps had mentioned. His belief was that there was no falling off, or next to none, in the illuminating power; and that the low results obtained in the photometer were simply due to the gas being tested under wrong conditions. The room was extremely small, had a sloping roof, and was lower at the end where the argand burner was than at the candle end. From experiments made with other photometers, he believed that this was largely the cause of the low tests given. He found that the more the argand burner was boxed in, the lower would be the results obtained with the same gas. It was extremely important that the burner should have as free an air supply as possible. With regard to complete combustion in the calorimeter, as far as he had found there was no difficulty whatever. When testing cannel gas of as high quality as 33 candles, the combustion had been perfect. The flame of the burner never came in contact with any solid matter until it was completely burnt. It had air all round it. One could not, however, consume cannel at the same rate as ordinary gas. With the latter, the consumption might be 4 to 8 cubic feet per hour; with cannel it was something like 2·5 cubic feet.

Mr. Forbes Carpenter remarked that the temperature of 20° C. seemed rather high.

Dr. Colman said, as a matter of fact, the general temperature difference was 17° to 18°; but one might work within a limit of 20°, and still have the waste gases leaving the apparatus at a temperature within one or two degrees of the water. One really might go higher—to 22° or 23°; but, at any rate, 20° was a safe limit. A question had arisen whether some enrichers did not have more effect on the illuminating than on the calorific power of gas. He had hoped to make a series of experiments on this point, but had been prevented from doing so. The results he had obtained so far showed that benzol affected the illuminating power three times as much as carburine; whereas the effect on the calorific power was exactly the same. Benzol raised the illuminating power of the gas three times as much as its calorific power. If these figures were confirmed, they accounted to a large extent for the higher calorific ratio found in the case of lower light-giving value, as the cause of the difference in illuminating power was largely due to the amount of benzol vapour present in the gas. Mr. Hunt was quite correct in supposing that he (the speaker) had hoped to find that the calorific power varied very closely with the illuminating power, and that it would be possible to say: "Here is an instrument that is better than the photometer, and the results are parallel." The results showed, however, that a variation of 10 per cent. was possible in the calorific ratio. Still, if they took the first table, giving a month's tests, it would be seen that the extremes of illuminating power were 16·47 and 18·0—a variation of some 9 per cent. during the month, while the calorific power in the same time varied 7½ per cent.; so that, although the tests were not parallel from day to day, the variations in the two values over a longer period were pretty much of the same order.

The Franklin Institute have awarded a John Scott medal and premium to Mr. A. M. Hopkins, for his pneumatic system of preventing the bursting of water-pipes by freezing.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

(For Stock and Share List, see p. 1240.)

Business on the Stock Exchange last week continued to be very limited indeed; and the tendency to inaction was aggravated by the usual May Day holiday. The general condition was flat; and the dulness of the week was only slightly relieved at the close by favourable war rumours. Prices all through the list are decidedly lower, with hardly a single advance anywhere to chequer the array. The most interesting incident for gas shareholders was the fall in the railway market, owing to a 50 per cent. advance in the prices of the new coal contracts. Gas men who are smarting under the exactions of the coal-owners, can sympathize with railway men here. In the Money Market, the demand was strong, and rates continued very stiff, though towards the close there was a little relaxation of the stringency. Business in the Gas Market was very irregular. On some days it would remain almost as quiet as could be; but in between quiet days an active one would be sandwiched. Taken altogether, it was a busier week than its predecessor. With one exception, all changes in quotation are downward, as might be expected; but these changes are not considerable in extent, except in the case of one Company, where a substantial reduction was made in view of the fact that the next dividend declared must necessarily be at a lower rate. What this rate may be, however, remains to be seen at a distant date. In Gaslight issues, dealings were at times very brisk in the ordinary; but they brought about no change—prices ruling at about 102 steadily. The secured issues also were unchanged. South Metropolitan promised at one time to be active, but soon quieted down. After touching 130, it fell to 127; and the quotation was lowered a point. In Commercials, only one "special" bargain was marked in the new; but both issues had their quotations put down with a rather liberal hand. There was a little more business done in the Suburban and Provincial group; and Brighton, British, and Crystal Palace gave way slightly. The Continental Companies were quieter than they have been for a long while; and there was no change in price beyond a fall in Tuscan. The remoter undertakings furnished a contrast, Australian scoring a rise; but Buenos Ayres was lower. In the Water Companies, business was extremely quiet and devoid of all feature. For the second week running all quotations have remained unchanged.

The daily operations were: Business in Gas on Monday was very quiet; and the only move was a fall of ½ in Tuscan. On Tuesday, the Exchange was closed. Wednesday was very brisk, with much dealing in Gaslight ordinary and South Metropolitan. Australian rose 1½; but Brighton ordinary receded 3, South Metropolitan 1, and British ½. Business fell quiet again on Thursday. Australian rose ½; but Commercial old fell 7½, ditto new 12½, and Buenos Ayres ½. Activity was renewed on Friday; being mostly in Gaslight ordinary, which held steady. Commercial old fell 10, ditto new 5, and Crystal Palace 1. Saturday was almost lifeless; and nothing moved.

ELECTRIC LIGHTING MEMORANDA.

A Serious Misstatement—Asserted Superiority of Electricity-Meters to Gas-Meters—A Flat Denial—Shareholders of Public Companies and the Membership of Local Authorities.

It is not often that we have to seriously complain of misstatements on matters of fact by our electrical contemporaries. We thoroughly understand each other's position, as a rule, and usually confine our differences of statement to matters of opinion. They, of course, advocate electric lighting and other applications of electricity for all these are worth; while it is our business to exhibit the "seamy side" of the same subjects. There is no pretence on either side to an impartiality which cannot possibly exist, and would be useless if it did. Impartiality is only another name for lack of interest; and without interest in the subject, it is impossible to do journalistic justice to any special branch of science or business. This being understood, it was with some disappointment that we saw in the current number of the "Electrician" a deliberate and quite gratuitous misstatement respecting the relative trustworthiness of gas and electricity meters. This occurs in a paragraph relating to some statistics as to the employment of electricity meters in Germany. The statistics themselves are rather curious. They are based upon returns collected by the German Physikalische-Technische Reichsanstalt, which has circularized the manufacturers and known users of electricity-meters in the empire, in order to find out how many, and what sizes of meters, are actually in use.

The figures thus collected exhibit a remarkable discrepancy. Nine firms of meter manufacturers reported that on July 1 last 126,000 meters were in use in Germany. The 950 central and private stations applied to, however, could only account for about 60,000 among them. The difference is charitably explained by reference to the number of meters in stock and not put into use, to those used for testing purpose, and to those exported. It occurs to one that the last-named class of trade

would not naturally be included in the tale of meters returned as being in use; but anyhow the unaccounted-for margin is wide enough to support the suggestion that the manufacturers must have taken a very generous view of the extent of their custom. Whatever the degree of accuracy of this part of the report, however, our contemporary, referring to a question put as to the permissible error, goes on to state that on this point—figure not given—"the makers and the larger supply stations were in agreement; but smaller works considered a greater degree of accuracy desirable, and one that is not attained in practice. *Of course, in all circumstances, the electricity-meter is more accurate than the gas-meter.*" We have italicized this statement, and declare it to be an absolute falsehood.

This matter, as the "Electrician" is well aware, is of great technical and commercial importance. Why, if it was deemed necessary to give the electricity-meter a general certificate of extreme accuracy, was the amount of error considered permissible by "the makers and the larger supply stations" omitted? What is it that these witnesses are agreed upon; and why should the smaller works desire a greater degree of accuracy, "and one that is not attained in practice?" Perhaps our contemporary is in ignorance of the degree of accuracy legally required of a gas-meter, and actually realized by the ordinary run of these instruments. We can inform the electricians that they have to compete with an appliance which, before being stamped for use, must register within the statutory limits of 2 per cent. fast, and 3 per cent. slow, and which, in fact, is rarely over 1 per cent. wrong. Moreover, the causes of error that do exist in either wet or dry gas-meters are such as to be more often and more considerably in favour of the consumer than of the supplier of gas. The official returns of gas undertakings throughout the country show that, while the proportion of the output of the works that cannot be accounted for is capable with good management of being brought down to about 4 per cent. under favourable conditions, it is not possible to get much nearer to a perfect balance-sheet; and this fact of itself testifies to the general accuracy of the meters. Last, but not by any means least, these articles cost only a few shillings, for the smaller sizes chiefly in use.

Now, on the face of the "Electrician's" own statement, we challenge it for its proofs of the assertion that "in all circumstances the electricity-meter is more accurate than the gas-meter." Let us have this contention established on irrefragable evidence; and when done, we will gladly acknowledge the truth, and call on the gas-meter trade to look to its reputation. We do not mean to let our contemporary off from this task.

A remarkable law-suit has been going on between the City of London Electric Lighting Company and the Corporation of London over the question of the validity of the City lighting contracts, which was impugned for reasons that will be within the recollection of our readers. It was a question, primarily, of the construction of the Acts of Parliament relating to the constitution of the now obsolete Commission of Sewers, which contained clauses to nullify any contract between this body and any firm in which a member of the Commission might be interested. The facts were not in dispute; the only point for the Court to decide was whether the interest of an ordinary shareholder of a public company was sufficient to come within the meaning of the Acts. The judgment of Mr. Justice Farwell is that this interest is not sufficient to nullify a contract for such a matter as the supply of electricity, gas, or water. The Court distinguished between contracts for construction works, and for public supplies of the kind specified—holding that the reasonable interpretation of the Act was that it could not be meant to prohibit the Commissioners from entering into a contract with a Gas Company for the supply of the City because one Commissioner happened to possess a single share in the Company. After this, let nobody indiscriminately repeat the immortal Bumble's qualification of the law.

Gas-Engines for Electric Traction.—The electric funicular tramway at Tibidabo, Barcelona, will employ a Crossley gas-engine of 300-horse power fed with Dowson gas.

The Price of Coal.—The Coalowners' Association have decided upon a minimum advance after June of 5s. per ton on the rates of the corresponding period of last year. They regard the alteration in the percentage of delivery referred to last week as reasonable, in order to ensure more regular working at the pits.

The Gas Section of the Paris Exhibition.—Our readers are aware that the Organizing Committee of the Gas Section at the Paris Exhibition are desirous that a portion of their collective exhibit should represent the history of the discovery of gas in different countries. This, they think, could be best done by photographs or copies of historical documents, patents, drawings, models, &c. Up to the present, notwithstanding the efforts made by the Committee, nothing has been received from England in connection with this matter, though this country has claimed so large a share in invention of gas lighting. The Committee suggest that England should at all events bring forward whatever title she is able to furnish in support of her claim. They therefore ask us to invite those of our readers who may be possessed of anything which will bear testimony to what their country has done in the way of helping forward, by improved processes, the science of gas lighting, to forward it without delay to the President of the Committee, M. Eugène Lebon, at No. 26, Rue de Londres, Paris.

ARBITRATION IN TRADE DISPUTES.

THERE constantly arises in the thoughts of the humane and reflecting among us, a deep sense of horror that war should be the only means of settling international disputes. Quarrels between individuals it is no longer lawful to resolve by mortal combat; the arbitrament of the law is practically the only remedy. Why then should not mankind agree to settle all disputes by means of arbitration? Such is the very natural cry of many—a cry that led to the enacting of that solemn farce, the Peace Conference at the Hague last summer, of which the value in preventing an appeal to arms has been so speedily made manifest. Similar feelings undoubtedly exist in the minds of all thoughtful men, as to the intensely unsatisfactory character of war considered as a method of solving differences between employers and employed. The same evils characterize the method in both cases. The cost to both parties, usually out of all proportion to the end gained; the misery and suffering entailed, not merely upon the actual disputants, but also upon those innocent of the quarrel and helpless to prevent or terminate it; the possible injustice of the outcome, through might prevailing over right—these, and more also, are common evils attendant upon international and industrial warfare alike. Is the prospect of substituting the peaceful method of arbitration for that of combat as dark in regard to industrial disputes, as it appears to be in regard to those between one nation and another? We think not; neither, however, do we think that it will ever be possible to bring about an entire displacement of strikes and lock-outs by the universal adoption of conciliation or arbitration organizations for the settlement of trade disputes. The determination of individual quarrels by duelling is prevented, partly by the intervention of the law (which is organized public opinion), aud partly by the fact that the person launching the quarrel stands to suffer directly by its reference to arms. International combat, on the other hand, remains as a determinant of disputes because there is no international police force to separate the combatants, and no tribunal before which to hale them; nor, even were there such a tribunal, would there be any means (except by war) of enforcing its decisions. Moreover, war may be, and has been, brought about for personal aggrandizement, by a statesman or a monarch who runs little or no risk of standing the racket. Industrial disputes may be said to lie between the two extremes; being checked by public opinion (both organized—that is to say, the law—and unorganized) and by the fear of self-injury, to a lesser degree than the individual, but to a greater extent than the nation.

When, therefore, we ask ourselves what obstacles lie in the way of the general adoption of conciliation or arbitration for the settlement of trade disputes, we find a partial answer in the fact that it is impossible to compel the parties to resort to such means, and in the absence of means to ensure the due observance by both sides of the terms of an arbitrator's award. (When we say "impossible to compel," we mean that the *primâ facie* case against any system of compulsory arbitration is so strong, while the results of such a system in actual working have been only recently shown to have been so deplorable,* that the possibility of the adoption of any such law in this country is outside the range of practical politics.) The remainder of the answer can best be found by considering—as we will briefly do—what circumstances and conditions are most favourable to the establishment and successful working of the machinery of arbitration.

Our attention has been drawn afresh to the subject, which is one of perennial interest, by a particularly able and thoughtful article which occupied the premier position in the "Edinburgh Review" for January; and we propose to confine ourselves mainly to a consideration of the suggestions contained therein. The writer (we need scarcely remind our readers that articles in the "Edinburgh" are unsigned), though primarily reviewing the question of "Conciliation and Arbitration in Trade Disputes," devotes the greater part of his article to a consideration of some of the causes which contribute to such disputes—choosing the present time as favourable to a dispassionate examination of the subject, on account of the comparative immunity from labour troubles now being enjoyed. In common with ourselves, the writer does not attribute that immunity, in any great degree, to anything but the general activity of trade; and therefore he deems it wise to consider—before the conditions tending to a recrudescence of disputes shall arise—whether any extension is possible of the methods available for the determination of differences when they may occur. The article is distinguished by the success with which the writer has attained to a detached and unpartisan view of his subject; though we do not say he has achieved complete impartiality. That is a gift beyond human reach.

The reviewer prefaces his discussion of the subject by claiming recognition for the fact that, be their faults what they may, Trade Unions have come to stay, and, moreover, constitute a powerful factor in the industrial world which must be reckoned with in any consideration of future possibilities. "The State could no more put down Trades Unions, or interfere with the right of workmen to combine, than it could interfere with the freedom of the Press or of speech." Recognition of the logical corollary of this right of combination—which corollary is rarely or never admitted by those who most strenuously defend that

* See "JOURNAL," Vol. LXXIV., p. 993.

right—is claimed with equal certainty of voice, and with a welcome vigour of expression. "The action of the State in supporting the rights as citizens of men who are opprobriously and unreasonably called 'scabs' and 'blacklegs,' has been half-hearted and unenergetic. It is otherwise in the United States, where liberty is as much cherished as in Great Britain. Unless freedom of labour involves freedom to work at will, as well as freedom to be idle at will, the operation of economical laws is unduly checked. The State, in our opinion, fails in its duty if it refuses or neglects to afford the necessary protection against illegal exercise of force to men or women desirous of accepting employment on terms satisfactory to themselves, if distasteful to others. And dread of temporary unpopularity ought not to influence those who direct the action of the State in this respect."

Trade Unionism being premised as an inevitable factor in the industrial problem, the writer proceeds to examine such of its methods and tendencies as are calculated to lead to a breach of the peace between men and masters. Reference is made to Sidney and Beatrice Webb's "Industrial Democracy," in order to demonstrate the deplorable "disposition to regard Trade Unions as belligerents continually seeking to alter the conditions of their employment under guise of improving the condition of a class, and leaving no stone unturned in the promotion of discontent and unrest." This disposition runs through the whole of the work referred to, and is shown especially in the attitude taken up by the authors, as the exponents of Trade Unionism, towards Benefit Societies instituted and supported by employers, and towards the introduction of profit-sharing. The objection urged against employers' Benefit Societies by these Trade Union advocates is that it tends to create amicable relations between men and masters—to the detriment of the sacred cause of Unionism. "It renders men indisposed to pay again to the Trade Union . . . . It holds out to them a strong and growing inducement to remain where they are, and thus accept employers' terms. . . . Any general adoption of employers' Benefit Societies would, in fact, go far to render Trade Unionism impossible." So with profit-sharing. Such arrangements between particular firms and their men "destroy community of interest"—that is to say, the employees of a "specially benevolent firm with a really generous profit-sharing scheme will not be disposed to join heartily with the rest in any movement for higher wages."

The comment of the Edinburgh Reviewer upon this attitude of the leaders of Trade Unionism is as follows (it is quoted at length as being the deliberate opinion of one obviously not prejudiced against Unionism in the abstract): "In other words," he says, "the wisest and most benevolent efforts of employers to help their workmen, to improve their condition, to make them contented, and to diminish the consequences of sickness or the expenses connected with death, are to be resisted and banned, lest the individuality of the workman should be kept unimpaired, and the slavish sacrifice of his own interests inculcated by the Union made to appear in its real colours. If individual freedom means anything, or has any value, the option of workmen to accept advantageous terms, to profit by the benevolence which softens the rigour of industrial life and gives workmen a direct interest in the success of the business at which they work, should be encouraged, not tabooed. The opposite policy can only tend to reduce men to the position of mechanical units, to curtail their judgment, to oust their discretion, and to set up a tyranny far more irksome than any which can be brought about by a despotic foreman, or a narrow-minded employer. We have always thought," concludes the writer, "that the charge brought against Trade Unions, of reducing men to slavery, annihilating their free will, and destroying, not only all contentment, but all disposition to be ambitious of progress and advancement, was greatly exaggerated. But the chapter [in 'Industrial Democracy'] from which we have made . . . extracts does little to disprove it."

The reviewer then points out, by means of quotation, how the defenders of Unionism naïvely admit "that Trade Unions fight at the greatest advantage, make many men bankrupt, and ruin trusts, when workmen are combined and employers are not. There is," he remarks, "no pause to consider whether it is for the advantage of trade that business firms should be bankrupt or companies ruined, or whether the sufferings of the wives and children of workmen during a long period of enforced idleness is not a wholly disproportionate price to pay for the attainment of limited concessions. All that is considered is the 'strategic advantage,' and the opportunity which it confers, not for peaceful progress, but for 'embittered and obstinate' war." Reference is next made to the fact that, although Trade Unions are slowly learning by experience, many "still adhere to their belief in two fallacies—the first, that wages regulate prices; and the second, that artificial limitation of output is for the advantage of wage-earners." The second is truly said to be most mischievous in its results, especially in regard to the opposition of men to the introduction of labour-saving machinery. The consequence of the greater stupidity of the English than the American workman in this respect, "is that an inventive nation is rapidly pushing invention, and that not only the British manufacturer is damnified, but also the workman he employs."

Having touched lightly upon other unlovely aspects of Trade Unionism conducing to labour disputes, and having expressed his opinion that employers should recognize Trade Unions, and negotiate when necessary with their leaders, and that they would act far more wisely by turning the influence of Trade Unions into proper channels [how easy that sounds on paper!] than by futile efforts to crush it—opinions that have never found acceptance in the "JOURNAL"—the writer discusses how best to accomplish the diminishing of strikes and lock-outs, and the bringing about of a more general acceptance of arbitration as a means of settling disputes.

The suggestion made is, briefly, that peace can best be preserved by armament. Just as in international affairs it is true that to be prepared for war is often the best means whereby to secure immunity therefrom, so it is suggested that the best hope of industrial peace lies in effective combination of employers. The history of the disputes in the engineering trade and in the South Wales coal-fields proved the strategic value of such combination; and in face of associations of the employers in each industry throughout the country, Trade Unions would find themselves powerless to conduct guerilla warfare against individual firms. Here we find the "circumstances and conditions most favourable to the establishment and successful working of the machinery of arbitration;" for between combinations mutually respecting each other's strength arbitration would certainly be more possible.

The difficulty remains of how to secure the due observance of awards. To remove this obstacle, the suggestion made by some of the Labour Commissioners, in a memorandum appended to the report of the Royal Commission, is recalled and endorsed—the suggestion, namely, that trade associations, whether of men or masters, should be allowed and encouraged to make themselves bodies corporate by registration, and should put themselves into a position of being sueable and able to sue. The successful working of the "settlement" in the boot and shoe trade—a voluntary arrangement by which either men or masters are fined for breach of the agreement, each side depositing £1000 as security for such fines—is instanced to show that arbitration can be made to run on these lines. The depositing of security is certainly a most essential feature of the arrangement, for it would be no use sueing a bankrupt Union.

We have now given a bare outline of an article which is worthy of careful perusal, and which we only wish could be studied by all the thick-and-thin supporters of militant Trade Unionism. There is, however, one point to which we think the writer should have given more consideration in his search for methods whereby industrial strife may be diminished. We mean to the possibilities of profit-sharing as a means to that end. The peace ensured by combination of man with master in the joint pursuit of their common interests, is based on a far more certain foundation than that subsisting between armed camps of employers and employed ranged over against one another. But, by whatever means ensured, peace is increasingly essential to the maintenance of our position in the commercial world; and every effort to secure a fuller measure thereof is welcome.

PERSONAL.

Mr. HUGH M'NAIR, of Wishaw, has been appointed Manager of the Strathaven Gas Company, in succession to Mr. John Stewart, who has gone to Lanark.

Mr. G. B. SMEDLEY, jun., Assistant-Manager of the Buxton Gas-Works, has obtained the appointment of Gas Manager and Surveyor to the New Mills District Council, in succession to Mr. E. Jones, resigned.

Out of 35 applicants, Mr. T. R. MURRAY, of the Halifax Corporation Gas-Works, has obtained the appointment of Assistant-Engineer to the Tottenham and Edmonton Gas Company, advertised in the "JOURNAL" some weeks since.

At the meeting of the Royal Institution last Tuesday, the list of officers elected for the ensuing year contained the names of Sir F. ABEL, Sir F. BRAMWELL, Dr. LUDWIG MOND, and Mr. A. SIEMENS among the Managers of the Institution.

With reference to the paragraph in the "JOURNAL" for March 13 (p. 671) on the subject of the appointment of Water Engineer to the City of Cape Town, we are informed that the position obtained by Mr. F. W. WARD HOLLAND is that of Engineering Assistant to the Water-Works Department.

On the occasion of the announcement of the results of the examinations in "Gas Manufacture" at the Polytechnic Institution last Tuesday evening, the conductor of the class, Mr. WALTER GRAFTON, F.I.C., F.C.S., was presented with a set of ebony hair-brushes and comb, in a morocco case, as a testimony of the appreciative regard of the students. The presentation was made by Mr. W. H. Johns, who, as mentioned in another part of the "JOURNAL," took the second prize in the Honours Grade. Mr. Grafton suitably acknowledged the gift.

We learn that at a meeting of the Directors of the Derby Gas Company held last Wednesday, Mr. HERBERT BULLIVANT was appointed Secretary, in succession to Mr. R. Fisher, who, as recently announced, is retiring from the service of the Company, with which he has been connected for more than half a century. Mr. Bullivant has been associated with the Company's clerical staff for upwards of 27 years; and for some considerable time he has assisted Mr. Fisher in the discharge of his secretarial duties. He will enter upon his new position on the 1st of July.

Mr. THOMAS WILSON, who for 47 years has been a most zealous officer of the gas and electric lighting undertaking of the Corpora-

tion of Leicester, was last Tuesday presented with a handsome inlaid rosewood cabinet desk and writing-case, fitted complete, upon his retirement from the post of Superintendent of the Belgrave Gate works. The presentation was made at the works by the Engineer and Manager of the department (Mr. Alfred Colson, M.Inst.C.E.), in the presence of the heads of the staff and representatives of the workmen. Mr. Wilson was greatly touched with the gift, and with the kindly expressions, both of regret at his retirement and of good wishes for a long and happy enjoyment of greater ease, by which it was accompanied.

We regret to learn that Mr. A. E. BROADBERRY, Engineer of the Tottenham and Edmonton Gas Company, met with a serious accident on Monday afternoon last week through falling from a scaffold on the works. He has sustained severe laceration of the muscles of the lower part of the back, and is compelled to remain in bed. We are pleased, however, to be in a position to state that on Saturday the report of the medical man in attendance was favourable; and the hope was entertained that Mr. Broadberry would soon be restored to his usual health. In this hope we most cordially join; and we are sure those of our readers who know Mr. Broadberry will unite with us in expressing sincere sympathy with him in an illness which we all trust may be but of short duration.

The announcement which appeared in the "JOURNAL" last week of the desire of the Directors of the Midland Railway Company to receive applications for the position of Gas Engineer was necessitated, we regret to learn, by the resignation of the present occupant, Mr. JAMES BROOKS, on account of ill-health. Mr. Brooks, it may be said, was born in a gas-works; his father, the late Mr. J. Brooks, having been Superintendent of the Litchurch works of the Derby Gas Company. Mr. Brooks commenced his business life under that Company, and worked his way up through the various offices to the position of Superintendent of the outdoor department, under the Engineer (Mr. Charles Taylor). This he held till December, 1885, when he was appointed Gas Engineer to the Midland Railway Company. Mr. Brooks resides in Nottingham; but his chief office is at Derby, where, in addition to having an oil-gas works, the Railway Company make considerably more than 100 million cubic feet of coal gas for their own use in the extensive carriage and locomotive works there. The whole of the numerous coal and oil gas-works on the Midland system were under his charge.

Mr. B. W. SMITH, of Smethwick, has obtained the appointment, advertised in the "JOURNAL" a few weeks ago, of Gas Engineer to the Walsall Corporation, in succession to Mr. W. Gorse, who took the position on the resignation of Mr. John Tindall. Mr. Smith has been at Smethwick nearly nineteen years; having entered upon his duties on July 11, 1881, and started the works, which were in the first place designed and erected under Sir Frederick Bramwell. Since he has been Engineer, the make of gas has increased from 123½ to 264¼ million cubic feet per annum; and under his supervision the interior of the old retort-house has been practically reconstructed, a new retort-house on the inclined principle erected, and the machinery and other portions of the works duplicated. At present the Committee have placed contracts, from his designs and specifications, for an elevated railway siding into the works, the bridge of which over the canal has a span of 158 feet, by which means a very large saving will be effected in handling the coal, both as regards cartage and wages in the works. They have also placed an order for four purifiers, 24 ft. by 36 ft. and 6 feet deep, and foundations. Before going to Smethwick, Mr. Smith was for upwards of seven years with Mr. Hack at Saltley—first as draughtsman, then as chemist and general analyst, and finally as general assistant. Prior to that he was for a short time in the laboratory at Fulham under Mr. Kirkham, having gone there from Pará where he had served five years as a gas engineer under Mr. A. F. Wilson. Mr. Smith is a member of the Midland Association of Gas Managers, before which body he has read several papers; and he was President in 1893. Walsall's new Gas Engineer has therefore had a good record.

OBITUARY.

The recent death is announced of Mr. A. T. SQUAREY, Solicitor to the Mersey Docks and Harbour Board. The sad event is noticed here from the fact that it was the deceased who some years ago got up the case for the Board in their action against the Liverpool Gas Company, which formed so expensive a sequel to the destruction of the Landing Stage by fire.

Mr. J. R. TALL, Manager of the Dartmouth Gas-Works, died last Sunday week at the age of 53. Mr. Tall had filled the position of Manager for 22 years, and had the confidence and esteem not only of the Directors of the Company but of the town at large. The funeral, which took place on Wednesday, was attended by the Mayor and Corporation, the Directors of the Company, and a large number of the tradesmen of the town.

The death took place on Saturday, the 21st ult., at the age of 62, of Sir FRANCIS MARINDIN, K.C.M.G., Senior Inspector of Railways to the Board of Trade. Our readers may remember that deceased conducted a few years ago some inquiries in regard to the development of electric lighting undertakings in London. He obtained his C.M.G. in recognition of his services in connection with the Egyptian State Railways; and on the occasion of the Diamond Jubilee he was made a Knight of the Order.

TECHNICAL RECORD.

OHIO GASLIGHT ASSOCIATION.

(*Concluded from p.* 1124.)

Mr. B. E. Chollar, of St. Louis, Mass., read a paper entitled "Some New Ideas about Oxide Purification." In order to get good results, both gas and oxide must be free from tar or other foreign matter, and clean in a mechanical sense. It was commonly supposed that the hydrated sesquioxide was the best form, and that anhydrous oxides were comparatively inefficient. But in his experience, which was supported by others, the anhydrous oxide was by far the better; and when the hydrated forms were used, they were to a great extent rendered anhydrous during the first regeneration. If air was not present sulphuretted hydrogen combined with the oxide to form ferrous sulphide; and if the fresh spent material was treated with dilute sulphuric acid, the sulphuretted hydrogen was set free. But when air was admitted with the gas, the fresh spent oxide showed little indication of the presence of ferrous sulphide, and when treated with sulphuric acid, gave off little or no sulphuretted hydrogen. It revivified more slowly; and while the ferrous sulphide could not be treated with an air-blast for revivification *in situ* without risk of everheating and fire, this variety of spent oxide could be so dealt with, and with comparatively no risk. When air was admitted in proper proportion, and the direction of the flow through the oxide reversed at proper intervals, a new process was effected. The foul gas and air attacked the ferric oxide, reducing it to ferrous sulphide and ferrous oxide; and the ferrous sulphide was immediately converted into ferrous oxide, with separation of free sulphur. Ferrous oxide would not combine with hydrogen sulphide, and air would not oxidize it to ferric oxide if a large proportion of hydrogen sulphide was present. As the gas flowed through the oxide, the proportion of sulphuretted hydrogen would be reduced, while the air remained the same, and therefore the intake part would be reduced to ferrous oxide before the remainder had lost its activity. If under these conditions the flow of gas was reversed, the clean half would remove the impurity as before; leaving the air free to oxidize the ferrous oxide in the part of the bed that had previously been fouled. This also held true with one or with any number of boxes. When one was foul and the other able to do the work, the foul box could be placed last in the series, and revived to an active state ready for another reversal. The clean gas would not absorb impurity from the foul oxide. The author illustrated his remarks by producing samples of oxide treated in the manner indicated.

In the course of discussion, Mr. Hayward remarked that oak, poplar, or white wood shavings, or sawdust, should not be mixed with oxide, because they contained a form of tannic acid; and it was fatal to the action of the oxide, which should always give an alkaline reaction. The acid also encouraged fermentation, which was attended with further formation of acid. In order to guard against the possible presence of acids, it was a good plan to mix lime with the oxide. Even when thoroughly carbonated, the lime would still neutralize acid. He, therefore, preferred either pine or spruce shavings. Other speakers were of opinion that the use of oak shavings had a bad effect on the quality of the gas. Mr. Stone thought that the troubles ascribed to oak were really due to the presence of free iron, or of insufficient oxidation of the new material. Mr. Doherty pointed out the importance of maintaining a proper temperature in the purifying-house, or of covering the boxes with non-conducting material in cold weather. Mr. Hayward further added that the troubles caused by oak shavings must not be confounded with those due to the use of new and incompletely oxidized material. They were all familiar with the formation and properties of iron carbonyl. Not only should they take care to get good oxide, but it was a simple matter to avoid the use of new oxide in the last purifier, or to use a check purifier charged with well matured oxide. Anything in the way of a close filter would take out the iron carbonyl; and even a layer of lime a few inches thick, which could easily be added, would be a preventative.

A paper by Mr. Peter Young, of Detroit, Mich., was read by the Secretary, in the absence of the author. The title was "Bye-Product Coke-Ovens as a Source of Gas Supply." Progress in the utilization of bye-products from coke-ovens had been slow—partly because the market values of the products had been low, and partly because the earlier efforts were not altogether satisfactory in regard to the quality of the coke. The principal difficulty was the neglect to proportion the several parts of the oven to the quality of coal to be treated, which had only recently been corrected. But with the advantage of correct dimensions in the retort coke-ovens, their use had largely extended. They were costly in the first place, and could not be operated with advantage on a small scale. A further encouragement to their adoption was afforded by the lessened production of tar and ammonia at ordinary gas-works, due to the introduction of carburetted water gas. Though there were at least a dozen retort coke-oven plants in America, only two were supplying illuminating gas to the public—in Halifax and in Boston; and it might be questioned whether, as gas-producers, they were operated as efficiently and economically as a well equipped modern gas-works. But at present prices of residuals, coke

could be produced cheaper by the retort oven than by the beehive pattern; and, therefore, in any locality where coke was being produced by the beehive-ovens at a profit, it would pay to introduce retort ovens. The minimum size of a coke-oven plant that could be made to pay was one producing 500,000 cubic feet of gas per day. The cost of such a plant, which would include twenty-five ovens, would be about £21,000, exclusive of buildings. A coal-gas plant of equal productive power, including ten beds of sixes, would cost about £6500. Coal-handling machinery would be a necessity in the first case, but scarcely worth adopting in the second. The bye-products obtained, after providing for fuel, would be 4000 cubic feet of 16-candle gas and 1400 lbs. of coke from the ovens, and 10,000 cubic feet of 16-candle gas and 990 lbs. of coke from the retorts—the yield of tar and liquor being the same in each case. From these figures, the relative values of the processes could be calculated for any locality, always remembering that the coke ovens must be run to their full capacity, with a regular production of coke and of gas, throughout the year. So the question would be whether to build a coke-oven plant equal to the minimum consumption only and to take care of the variations with a water-gas plant or retorts; or to make the coke-oven plant equal to the maximum demand, and to utilize the surplus gas in various ways. The state of trade, the severity of the winter, and other causes, led to a much greater variation in the coke trade than was experienced with gas; and the question arose, "Will it pay better to go into the coke trade, to sell gas, or to stay in the gas business, and sell coke?" In nearly all localities gas coke realized as good prices for domestic use as oven coke; but where a steady demand for oven coke could be created, at better prices, then the coke-ovens would be a judicious investment. The average cost of labour in a coke-oven plant was about 1s. 3d. per ton of coal; but he had heard that inclined retorts had been erected subject to a guarantee to take the coal from the trucks, and load the coke on rail, for 9d. per ton. After allowing for purification and other labour, this compared very favourably with the ovens. It was claimed that the ovens would use slack and other small coals that could not be dealt with in retorts. With the ovens, two sets of holders would be necessary—one for the illuminating and the other for the fuel gas—and also two sets of hydraulics, condensing, and purifying apparatus, though in a small works these might be dispensed with. And to supply 500,000 cubic feet of gas to the consumers, it would be necessary to treat 125 tons of coal in the ovens and only 50 tons in the retorts, which meant 2½ times the quantity of products to be disposed of. At Halifax, endeavours had been made to render the total production of gas saleable by enriching the fuel gas; but it proved unprofitable, as over 2 gallons of oil per 1000 cubic feet of gas were required. At Halifax, the whole of the gas was saleable; and the production had to be supplemented by ordinary retorts. But at Boston, the surplus gas was sold to neighbouring gas-works at 10d. per 1000 cubic feet in the holder—quality not less than 14 candles. There was now an excellent demand for coke of all classes, and he understood that the Boston Company had made contracts for several years forward, based on current prices; and he thought coke would largely displace anthracite coal. As coke producers, the retort ovens were a success; but as gas producers, they could not compete with ordinary gas-works. It required 60 per cent. of the gas to accomplish the work done by 25 per cent. of coke, which might be valued as 24s. for the gas and 4s. for the coke. Another defect was want of elasticity, as the oven plant must be operated at full capacity to make it profitable.

Discussion being invited, Mr. Lynn said that the paper was valuable as coming from one who had practical experience with coke ovens. On the basis of the figures given, the interest on the increased investment alone would be £2 16s. per day, which would have to be credited to the gas. Figuring on a fair average value for oven coke, the revenue per ton of coal would be £1 11s. 6d. from the ovens and £2 13s. from the gas-works. But using 2½ times as much coal, the ovens would yield a greater return per diem than the retorts. He thought that gas coke as a rule realized much better prices than oven coke. It appeared from the paper that coke-ovens were out of the question for a production less than 500,000 cubic feet of gas per day. Even in large works, it might be found that the expense of running the ovens during the summer was greater than that of working retorts. Mr. Butterworth said that the Columbus Gas Company were looking forward to erect bye-product coke-ovens so soon as the supply of natural gas should fail or materially decrease. He had visited the New England Gas and Coke Works, near Boston, and thought they were doing excellently and had good prospects. They were making 1500 tons of coke per day, all of which was sold in advance, and were preparing to increase the output. They were supplying 18-candle gas, taking for this quality 35 per cent. of the total production. He understood producers were to be erected to maintain the temperature of the ovens in cold weather, and to admit of a greater proportion of the gas being sold in times of large demand. There was considerable demand for coke in the neighbourhood of Columbus; and he thought they could venture on the enterprise with a fair hope of success.

In the discussion on the contents of the Question Box, there was a general agreement that cannel was a cheaper agent for enriching gas than naphtha or oil at present prices. In the course of a reply to an inquiry as to the advantage of enriching gas above 18 or 19 candles, Gen. Hickenlooper expressed a decided preference for straight 17-candle coal gas, which contained the greatest number of heat units, and was therefore most serviceable for stoves and for Welsbach burners. Mr. G. D. Roper said that the lower power gas required a good pressure—say 2½ to 3 inches—and with that it yielded better results than high power gas at lower pressures. It was not so much a question of economy of gas, as of time in doing the work. In boiling water, the consumption of gas would be about the same, at varying pressures; but the higher the pressure the shorter the time occupied. Mr. Doherty remarked that the construction of the burner had a great deal to do with that. The higher pressure made a better and more complete mixture of gas and air, and this could be obtained at a lower pressure by a more careful consideration of the structure of the burner. Also, it was not sufficient to get all the heat out of the gas, as the question of the temperature of the flame and the intensity of the combustion had a great deal to do with the practical results. The higher pressure secured a higher flame temperature, and therefore better results in practice. Especially was this the case as regards the Welsbach burner. A question having been asked as to the practicability of utilizing the waste heat from retort-benches by means of the Yaryan system, Mr. Doherty explained that the system named was an arrangement for utilizing the heat in waste steam or furnace gases, by causing it to heat water contained in a large tank having a circulation system extending to the premises where the heat was to be supplied, and a pump for sending the water through the pipes. An ordinary retort furnace gave off 400,000 or 500,000 cubic feet of waste gases per day at a temperature of not less than 800°; and the heat thus wasted represented that afforded by 3 to 5 cwt. of coal. His idea was that this heat could be absorbed by a kind of gigantic instantaneous water heater, in which the water came into direct contact with the hot gases. He favoured the appointment of a Committee to inquire into this process; and he further remarked that the extent of waste heat above named, indicated that the limits of fuel economy and waste heat regeneration were not yet exhausted. Of course, they were not pinned to the use of water—steam might be found preferable. But several electric light companies had turned attention to the utilization of waste steam heat in this manner; and the retort-bench had the advantage, as compared with the boiler furnace, of a constant regular production of heat during the twenty-four hours. The Yaryan system was in successful operation, and many electric companies were recovering the cost of their coal from the waste heat of their steam. No doubt there was a large amount of low temperature waste heat in all factories, forging works, &c.; but very few of them had the advantage of a steady 24 hours' production. He proposed the appointment of a Committee of Inquiry, which was seconded and carried. Answering another inquiry, Mr. Andrews said that the waste in crushing coke was anywhere between 5 and 15 per cent., and that "egg-sized coke" was that which would not pass a 1½-inch screen, "nut coke" would not pass a ¾-in. to 1¼ in. screen, and "pea coke" would not pass a ⅜ in. to ¾ in. screen. A revolving screen was of advantage, as the stationary ones were so apt to choke.

The usual executive session was held, at which members only were present, and the proceedings are not recorded for publication. As the result of a long discussion, a deputation was unanimously appointed to confer with other Gas Associations, as to the creation of a fund by the Associations, or by gas companies, for the establisment of a National Advertising Bureau, for the purpose of advertising the advantages of gas appliances. Another deputation was appointed to confer with Electrical Associations on the subject of municipal ownership. A Committee was appointed to deal with the question of electrolysis in connection with other Associations and otherwise.

The usual votes of thanks were passed, and the meeting closed.

EXAMINATIONS IN GAS MANUFACTURE.

At the Meeting of the Manchester and District Junior Gas Association on the 28th ult., Mr. S. E. Halliwell, of Littleborough, read a paper on the above subject.

The author commenced by pointing out the importance of the examination question for educational purposes, and its interest to Associations such as the one whose members he was addressing. He referred to the value to students of the certificate in "Gas Manufacture" of the City and Guilds of London Institute, and expressed regret that it was not more appreciated by companies and corporations. He thought he was right in assuming that, in some cases, influence was a more powerful factor than merit when positions were being filled; and he considered this was to be deplored, as the highest standard of efficiency could not be attained under such a system. He did not for a moment contend that successful candidates at an examination in "Gas Manufacture" were necessarily qualified for the more responsible positions; but the very fact of passing proved, he thought, a knowledge of the subject, while the determination to compete evinced a desire for self-improvement. Moreover, the efforts put forth for such examinations necessarily increased one's technical knowledge, and rendered the student more capable of taking a position of responsibility. He reminded his audience that the certificate in "Telegraphy" of the City and Guilds of London Institute was recognized by the Post Office as qualifying

IMPORTANT NOTICE.

For the PROTECTION of WELSBACH AGENTS and the TRADE GENERALLY.

1.—MANTLES.

It is highly desirable that, in their own interests, the Agents of the Welsbach Company and the Trade generally should clearly understand that statements to the effect that the "Monopoly of the Welsbach Company came to an end with the expiration of the 1886 Patent"

ARE UNTRUE.

The present process, under which the Welsbach Mantles are made and which infringers imitate—described by the Court of Appeal as **"a remarkable and astonishing discovery of LATER TIMES,"** was first disclosed in the 1893 Patent, the **Welsbach Company's Patent Rights** in which

EXIST UNTIL 1907

and the Company will continue to uphold its rights, and to suppress all infringers of Mantles as well as of Burners.

In a circular dated 28th February last, the Sunlight Company states that the Welsbach Company "failed against their predecessors," the New Incandescent (Sunlight Patent) Company, Limited. The Judgment of Mr. Justice Buckley, of which the following is an extract, **will show how little truth there is in this statement:—**

> "In my opinion there has been an infringement of the Patent. . . . . I make the order therefore for an enquiry as to damages, and for delivery up . . . . and I therefore give the costs as between Solicitor and client."

It is also suggested that the Welsbach Company's action against the Sunlight Company for Infringement of the 1886 Patent has also failed, whereas the fact is that the Judge declined to **grant an interim injunction** on the ground that the duration of the (1886) Patent was so short. The Sunlight Company were ordered to keep an account, and the action for damages for Infringement against them will come on in due course. As the present Sunlight White Mantle is identical with that which Mr. Justice Buckley found to be an infringement, it will be seen that the Welsbach Company were entirely justified in the warnings they have given.

There is a further action pending against the Sunlight Company for infringement of the Welsbach Company's 1893 Patent, and it is claimed that the Sunlight Mantle is an even closer infringement of the 1893 Patent than of that of 1886, in which case it was held that the Defendants infringed "by using the material, namely, Thoria, suggested by the Patent of 1886." But for the delay resulting from the repeated applications of the Sunlight Company to the Court, this action on the 1893 Patent would have been settled before the expiration of the 1886 Patent.

The Welsbach Company is therefore still compelled to warn Dealers and the Public against BUYING, SELLING, or USING the SUNLIGHT WHITE MANTLE.

2.—BURNERS.

The Welsbach Company **repudiate absolutely** the statement that the New Welsbach Kern Burner is an infringement of the De Mare Patent, and the threats of the Sunlight Company should be ignored. At the time the Welsbach Company acquired the Kern Patent, they satisfied themselves that the Kern Burner did not infringe the De Mare Patent. The crude suggestions for a burner contained in De Mare's specification have been exhaustively tested by the Welsbach Company, and found useless.

The "Kern" Burner was brought out in 1897, and is unlike anything to be found in the De Mare Patent, **which makes no reference to a "chimneyless" burner.**

It cannot be too clearly understood that the New Welsbach "Kern" Burner embodies **absolutely new and original features** based upon a most interesting and valuable scientific discovery.

The Welsbach Company, convinced of their rights, have notified the Trade that they are prepared to defend any action which may be brought with respect to the "Kern" Burner, and to indemnify the persons attacked from all consequences.

The Welsbach Incandescent Gas-Light Company, Limited,

78, York Street, Westminster,

LONDON, S.W.

OVENDEN,

HALIFAX.

JONAS DRAKE & SON

Telegraphic Address: "DRAKESON HALIFAX."

Telephone No. 43, HALIFAX EXCHANGE.

Gas = = = = Engineers, = Contractors, and *Carbonizing Plant = = = Specialists. =*

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the holder for increased remuneration; and he thought that if the Institute's certificate in "Gas Manufacture" obtained similar recognition, the effect would be to encourage closer study of the scientific principles underlying the manufacture of coal gas.

Having referred to the increased popularity of the examinations in the subject referred to, as shown by statistics supplied to him by Sir Philip Magnus, the Institute's Superintendent of Technological Examinations, Mr. Halliwell pointed out that while the number of entries in the Ordinary Grade had risen from 40 in 1889 to 103 in 1899, and in the Honours Grade from 19 to 65, the percentage of failures had also risen from 12·5 to 42·7 per cent. in the former, and from 26·3 to 66·1 per cent. in the latter grade. He considered there were many factors which might, to some extent, account for this large proportion of failures; one being, no doubt, the increased difficulty of the papers set, especially in the Honours Grade—many subjects being now comprised in the syllabus which have not hitherto been included, such as the production of carburetted water gas, the various methods of enrichment, labour-saving appliances, &c. Moreover, there was in many districts an absence of local assistance in the shape of classes, as many educational authorities did not care to undertake their formation, owing to the small number of students who would be likely to attend them. Another reason for the high percentage of failures was lack of preparation. This applied even where classes had been formed; for mere attendance was not sufficient. Many students who entered as candidates for examination considered preparation superfluous. The author maintained, however, that it was absolutely indispensable for the attainment of any degree of success, especially at the present time.

Without attempting to deal with the working out of an examination paper, Mr. Halliwell proceeded to indicate several points which he thought would be acknowledged to be essentials for a pass. In the first place, sketching was no doubt a very important factor, as it was a most ready means of proving a student's knowledge. He quoted the remarks on this subject contained in the "JOURNAL" for Nov. 1, 1898, based on the report for that year of the Examiner, Mr. Alfred Colson, who said that; while many of the candidates' sketches were excellent, there was considerable room for improvement. Mr. Colson also commented on the all-round knowledge of the students, as evidenced by the papers of those who passed; and he recognized that attention was being paid to his reiterated warning that "one-sided knowledge, either in the engineering or the chemical branch of the industry, is not sufficient to merit a certificate." Mr. Halliwell thought it might therefore be fairly concluded that "good sketching, good composition, and an all-round knowledge of the subjects, are necessary, if good results are to be attained; and that to attain any degree of efficiency in these essentials, thorough preparation is necessary." As to the time allowed for the Honours paper, he regarded it as insufficient for giving exhaustive answers to the questions; and he considered the Examiner ought not to expect model replies and sketches made with mathematical accuracy in the short period of three hours. Having cited the questions in last year's Honours paper in support of his views on this point, he expressed the opinion that the syllabus in this grade covers too wide a range of subjects to be dealt with in a one-night examination with anything approaching satisfaction; and he supported our own suggestion that it should extend over two nights. We proposed that one paper should cover the ground from the retort-house to the station meter, including the analysis of coal and gases; and that a second paper should deal with the apparatus from the gasholder to the consumers' burner, including the testing of gas and the treatment of bye-products. Mr. Halliwell's view was that the whole subject might be divided into two sections—"Engineering" and "Chemical"—one night to be devoted to each, and certificates to be granted in each section. He thought this would be a more thorough test of a student's knowledge in both sections than that afforded by the present system.

The author passed on to deal with the lack of facilities offered to students for acquiring a sound scientific knowledge of gas making apart from the every-day routine of their own particular works. He advocated the extension of the class system, or even tuition through the post. Referring to the scheme formulated by the Gas Institute in 1887 for the inauguration of lectureships in various towns, for the benefit of the younger members of the profession, and supported by grants from the funds, Mr. Halliwell regarded the step as a desirable one to take, and expressed the opinion that many districts would avail themselves of such an offer. Classes might, he thought, be formed where no educational facilities, as far as subjects connected with the gas industry are concerned, at present exist. In view of the competition of the electric light, he regarded it as highly necessary that the younger members of the gas profession should prepare themselves in every possible way for their future career. He quoted the remarks of Mr. W. Foulis, in his Inaugural Address to the Gas Institute in 1887, on the need of higher education, and of greater scientific accuracy and investigation in all the details of gas manufacture. Emphasizing these observations, he urged the importance of thorough training for those who intend to occupy responsible positions in the gas industry, in order that they might be able to keep pace with the ever-increasing competition of other illuminating and heating agents.

Turning to the social side of his subject, Mr. Halliwell alluded to the absence of facilities for intercourse between the younger members of the gas industry; and he advocated the formation of more Junior Associations. Their establisment would, he said, effect a blending of the knowledge of the members which would prove mutually beneficial, for, by means of papers read on various topics affecting the whole routine of gas manufacture, and the discussion thereof, visits to works, comparison of experiences, and, if possible, exchange of papers, a system of mutual educational improvement would be established which could not but have a good effect on the future of the gas industry, as it would create a higher standard of efficiency in assistants which would be decidedly advantageous in conducting gas undertakings.

VITRIFIED-CLAY PIPES FOR GAS AND WATER MAINS.

Reference has already been made in the "JOURNAL" to the use for water-supply purposes of pipes made of vitrified clay. The utilization of this material for gas-mains was dealt with in an article in the "Iron and Coal Trades Review" for the 6th inst. The author states that the suitability of vitrified-clay pipe for the purpose mentioned is due to its possession of the following properties: Cheapness, durability, strength, slight susceptibility to changes of temperature, and non-porosity; and he considers these properties in the order named.

Cheapness.—Vitrified-clay pipes can be had, in quantity, in 4-feet lengths, and with large and strong sockets similar to the bowls of cast-iron gas-pipe, at much lower prices. The 4-feet lengths would, however, necessitate the making of three times as many cement joints in a line of clay pipes as in a line of cast-iron pipes of the usual 12-feet lengths. The following is, therefore, a rough but fair comparison of the costs of a mile of 6-inch vitrified-clay and cast-iron gas-mains, exclusive of excavating and refilling:—

	Fire-Clay.		Cast Iron.
Cost of pipe in trench, at 3d. and 1s. 5½d. per foot	£64	..	£370
Cost of making 1320 and 440 cement joints, at 12½d. each	66	..	22
Total cost	£130	..	£392

For sizes of main larger than 6 inches, the saving would be still greater.

Durability.—Vitrified-clay pipes are even more durable than those of cast iron, as they do not rust or corrode. No chemicals or substances in the earth, foreign or otherwise, seem to attack them. They are practically indestructible, and retain their strength and non-porosity indefinitely. The author recently examined a piece of vitrified sewer pipe that had been buried for 35 years, which, when cleaned by an experienced sewer-pipe manufacturer, could not be distinguished, whether by appearance or any other test, from freshly made pipe.

Strength.—While vitrified-clay pipe is not so strong as cast iron, it is nevertheless amply strong for gas-mains. These pipes do not break or crush when used for sewers; why should they do so when used for gas-mains? The tensile strength of vitrified pipe, whether of fire-clay or shale, is astonishingly great. Ordinary single-strength 6-inch vitrified fire-clay sewer pipes, with walls ⅝ inch thick, withstood an internal hydraulic pressure of from 90 to 120 lbs. per square inch; while 6-inch vitrified-shale pipes withstood from 140 to 180 lbs.—one piece not bursting even at the latter pressure—and 12-inch shale pipes, with walls 1¼ inch thick, have withstood an internal pressure of 220 lbs. A 2-feet length of 4-inch vitrified fire-clay pipe, selected at random, with walls ½ inch thick, was supported at both ends, and a weight of 2800 lbs. was suspended from the middle of the pipe before it broke. Vitrified-clay pipes may be brittle, as are also cast-iron pipes; and like them, they can be easily broken by a sharp blow, such as they would never receive when in use as gas-mains. But they are extremely strong, and do not readily break under a steady strain, such as they might be subjected to when buried in the earth. The difference between them and cast-iron pipes in this particular is not great, and the advantage is only slightly on the side of the cast iron.

Slight Susceptibility to Changes of Temperature.—The relatively high coefficients of expansion of iron constitutes a serious objection to the use of this material for mains. Iron mains frequently break, and their joints generally leak, on account of excessive expansion and contraction of the pipe due to changes of temperature. On the other hand, the expansion and contraction of vitrified-clay pipes, laid at the usual depth of gas-mains, would be very slight indeed—in fact, practically *nil*. Although the coefficient of expansion of vitrified clay has apparently never been determined, it is safe to assume that, inasmuch as it partakes more nearly of the nature of common brick than of glass, it is no higher than the average of the coefficients of these two materials, or (say) only one-third that of cast iron.

Non-Porosity.—Vitrified-clay pipes are, except possibly at enormous pressures, absolutely impervious to gas, while cast-iron pipes are more or less porous at ordinary gas pressures.

All things considered, there really seems to be no reason why pipes made of vitrified clay cannot be used, with satisfaction and great economy, for gas-mains. There would appear to be no difficulty in making good tight joints with cement, as the bowls can be formed exactly like those of cast-iron gas-pipe, with plenty of strength to withstand the calking in of jute or other packing. Of course, the vitrified-clay pipe must be selected and

laid with care, but not more carefully than cast-iron pipe, which is almost as nearly non-elastic, and which needs a firm and solid bearing throughout its entire length. The bottom of the trench should be scooped out to conform to the shape of the clay pipe, the earth should be thoroughly tamped round it, and a thin plank should preferably be laid over it to protect it from puncture by picks, &c. If the vitrified-clay pipe is laid as carefully as cast-iron pipe, the breakage due to settlements will be no greater, while that due to expansion and contraction will be less, as will also be the leakage. It may be found best also to use "ring" pipe without sockets, and employ a pitch or other flexible joint.

The following particulars in regard to a line of vitrified pipe to be laid for the supply of water to Hartford (Conn.) recently appeared in the "Engineering Record."

The water supply of Hartford is obtained from a series of connected reservoirs, which have recently become inadequate for the city's needs. An additional watershed is to be utilized; but, while this is in course of development, it is proposed to prevent the loss of water from existing sources as much as possible. Between two of the basins there is now an open channel about 3 miles long, which is believed to be far from water-tight along four-fifths of its route. Mr. Rudolph Hering was recently retained to suggest means of preventing this leakage, and he advises the use of a vitrified pipe-line under very slight pressure, although able to withstand a head of 10 feet occasionally, should such a pressure be necessary. The prevention of the leakage through the canal banks and bottom would involve either a masonry or a puddle lining, for it has been found impracticable to prevent it by running muddy water through the channel. Unless masonry is started below the frost-line, it will be injured, and thus fail to accomplish its purpose, which makes puddle the only practically useful material under the given conditions. This plan involves puddling the bottom and sides with at least 12 inches of clay, protected with not less than 8 inches of earth. If the work is carefully done, and the material is of the proper kind, the canal will not only become water-tight, but the frost will not permanently injure the lining. An estimate of the cost of this work has been made. Assuming that the bottom of the section is only 6 feet wide, and the entire puddled section of it is 22 feet wide, that no additional rock excavation is allowed for, that excavation is estimated at 50 c. per cubic yard and puddling at 8 c. per cubic foot, the cost would be $3 per foot run. Assuming, as before, that 80 per cent. of the canal length required such treatment, the cost would be $36,960.

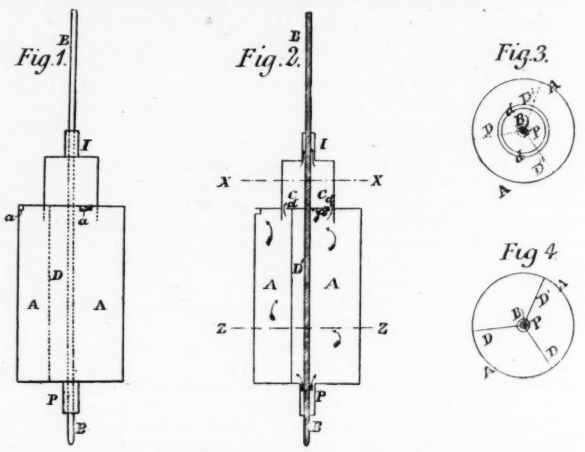
To repair the canal thoroughly in this manner would cause it to become water-tight; but it should be added that the conveyance of water for three miles in a shallow open ditch is not the best sanitary method of dealing with water for a potable supply. The only redeeming feature of this particular canal is the collection of rain water from a strip of territory draining into it, amounting to from one-half to two-thirds of a square mile. In view of the intention to increase the water supply for the city in other directions, this gain is not material. The aëration of the water in the ditch is of no advantage after the much greater aëration it has received in the large reservoir. It will not take out the solid organic matter or destroy bacteria. It removes iron when the water is impregnated with it, and gases when the water is polluted. For these reasons, it is held that a more satisfactory means of conveying the water from one basin to the other is afforded by closed conduits, in which the water is protected from dirt and heat—the latter a matter of some importance where the depth of water is slight.

If the total available head between the two reservoirs is utilized, then cast-iron pipe must be employed, according to Mr. Hering. If the head is not greater than 10 feet, then carefully selected and well-jointed double-strength vitrified pipe will answer. The latter is imperishable, and will retain a smooth interior; thus retaining also its original discharging capacity. Iron pipe will become tuberculated inside, and thus generally and gradually have its discharging capacity reduced. On account of this fact, and of the greater economy of vitrified pipe, the latter is given the preference in the Hartford case, even though a less head, and therefore a smaller discharge, is obtained by it. If the vitrified pipes are well selected, so as to fit without interior projections of more than $\frac{1}{8}$ inch, and thus reduce the fractional coefficient to a practical minimum (Kutter's $n = 0{\cdot}012$), the pipe, if laid at the lighter grade, will discharge 5,823,000 gallons per day; if laid with the better grade, it would discharge 8,583,000 gallons per day. In both cases it is assumed that the pipe does not run under a head. By giving the water a head of 10 feet above the pipe at its upper end (the greatest head to which it should ever be subjected) the discharge would respectively be 7,064,000 and 9,417,000 gallons per day. The estimated cost of the pipe of smaller capacity is $31,500, and that of the other $33,000. The latter was recommended; and the Water Board have decided to build it. The difference between its first cost and the expense of puddling the old canal is not the only favourable feature it presents. It will still leave the canal free to collect the run-off from the adjoining district in times of drought; it will protect the water from injurious influences, as before stated; and it will be less expensive in maintenance and repairs.

REGISTER OF PATENTS.

Separating and Extracting Gases from a Gaseous Mixture, Purifying, Exhausting, and Compressing Gas, and Increasing its Illuminating Power.—Mazza, E. N., of Turin. No. 20,494; Oct. 12, 1899.

The mechanical apparatus forming the object of this specification has, says the patentee, been "suggested by the laws governing centrifugal force arising in bodies that are made to revolve on a point or on a right line. If a sufficiently rapid rotary movement is given to a gaseous mixture whose components are sensibly different in specific gravity (and so much the better as this difference is greater), by the action arising from centrifugal force, the denser gases will go to the periphery, and the lighter gases will gradually dispose themselves near the centre."



He then proceeds to describe the invention by means of drawings, in which fig. 1 is an elevation of the apparatus; fig. 2 is a vertical section; fig. 3 is a horizontal section on the line X of fig. 2; and fig. 4 is a horizontal section on the line Z.

A is a drum revolving on a shaft B, to which it is rigidly fixed by means of several diaphragms D, D^1, D^{11}. The drum (which revolves vertically on its shaft) is closed at the bottom, leaving a central inlet P for the gaseous mixture to be decomposed. It is divided into several compartments by these diaphragms; and it has one or more other compartments C, according as two or more constituents have to be separated from the mixture. If the shaft, and the drum and diaphragms with it, are made to revolve at a suitable speed, it will cause in the middle a rarefaction, which will result in the gaseous mixture rising through the central flue I. The diaphragms violently force the mixture towards the drum; and at the same time it ascends. Then, when it arrives at the upper part, the separation will be complete, and the gases of the mixture can be distributed in concentric rings according to their different densities. The denser will go out by the openings a, and the less dense by the openings d, and finally pass out at I.

In the specification, some practical applications of the invention are described; and some extended reference to these will be of interest. As is known, common illuminating coal gas (the patentee remarks) is essentially a mixture two-thirds of which are hydrocarbons that give the illuminating power, and the remaining one-third is hydrogen giving only heat. The same illuminating gas is employed for lighting, heating, motive power, and, in some cases, for smelting, &c. In the first instance, it would be desirable to have it of great illuminating power, which, if necessary, is artificially increased (for instance, by carburetting the gas). For the other applications, it would be preferable if it were of great heating power. Several means have already been invented for increasing the illuminating power; but, on account of the facility with which, by means of the separator and extractor here described, centrifugal force can be applied to totally or partially collect the hydrogen of coal gas, it is proposed to extract by this apparatus a sufficient portion of it, in order that the remaining hydrocarbons could give the desired greater illuminating power. In this way, the problem of adding some carburetting substances to increase the illuminating power of a gaseous mixture on ignition, would be substituted by "the simpler and also less expensive one" of taking away a portion of the hydrogen (which by its presence would lower the light of the mixed incandescent hydrocarbons), and so indirectly increase the luminosity of the hydrocarbons. Therefore the physical and mechanical process and the apparatus here referred to, "make it possible to separate, with very little expense," the pure hydrogen gas from the hydrocarbons as soon as they issue from the retorts in which they are produced, and then to forward them to two distinct reservoirs—one to be applied to lighting, and the other to industrial uses.

It is a known mechanical law that the resistance of bodies to the fluids striking them, changes proportionally to the square of the speed for the same surface. Consequently, the motive power necessary for obtaining a given amount of work would be saved in proportion as the striking surface of the bodies and fluids would be lessened. In the compressing extractors now in use, the shock of the gas against the vanes is produced on the two lateral surfaces and on the imaginary belt that would envelop the vanes. On the contrary, in the apparatus here described (in which the diaphragms take the place of the vanes with the same object of imparting a rotary velocity to the gas molecules), the fluid is struck by the diaphragms only in the inlet and outlet openings strictly calculated, and in the whole passage in the drum there is only the transporting in the interior and the friction on the exterior face of the drum. Then, before acting as a separator, the apparatus acts as a rotary extractor by the aspiration produced near its axis by centrifugal force acting at the periphery; and consequently in its greatest intensity between the axis and the periphery of the revolving fluid cylinder, there is not, and cannot be, any interruption.

The centrifugal force to which the fluid is submitted when in the moving drum, produces the separation of its components of different density; and the gas, by the acquired rotation, escaping from the drum will have a projecting velocity that can always be utilized for augmenting the pressure, so that the apparatus can be used as a compressor. It would be sufficient to enclose it in a strong, fixed, gas-proof casing, having at its two ends the necessary orifices for the gaseous mixture at first, and for its constituents after the operation of the rotary motion.

Then, as a compressing extractor, the apparatus is distinguished from any other actually in use by having the vanes or diaphragms rotating with the drum; and the shock of the fluid or gas being only produced at the orifices of the inlet and outlet on a surface that is always less than that of the vanes against which the fluid or gas strikes in the ordinary apparatus. At the same time, the apparatus could always be used as a separator, if the coal employed in the production of the gas was of inferior quality, or giving a gas without the necessary degree of luminosity; and it would not be necessary to have two different systems of pipes, but it would be sufficient to have two gasholders.

In gas-works, the apparatus could be used in "an important manner and more continually." As it is known, the greater impurities of illuminating gas (say, tar, carbonic acid, and hydrogen sulphide) are all denser than the illuminating gas itself. It would thus be easy, by means of the apparatus, to collect the whole mass of the impurities in a single operation, or in two consecutive operations. In this way, the condensers and the purifiers "would be abolished," with the consequent economy of the power necessary to work them. The impurities could also be collected and utilized better than at present. The cyanogen collected could be made into cyanides; and the hydrogen sulphide into sulphuric acid (without needing the special furnaces now used for the sulphides and sulphates). Another advantage for gas-works would be in "the suppression of the washing of the heavy hydrocarbons in order to obtain the ammonia mixed with them." The ammonia, by the action of centrifugal force, would be separated with the hydrogen, and the methane, which would not be affected by washing in ammoniacal liquor, while the heavy hydrocarbons would lose about 5 per cent. of their illuminating power.

Regenerative Coke-Ovens on the Everett System.—Schniewind, F. W. C., of Everett, Mass., U.S.A. No. 3335; Feb. 20, 1900.

This invention relates to coke-ovens of the kind in which regenerative chambers heated by the escaping products of combustion from furnaces used in heating the ovens are employed to preheat the air which is passed to the furnace to support combustion; and, generally speaking, it may be said to consist "in connecting the cooling-flues with the conduits leading to the regenerators, providing means for directing the hot air coming from the cooling-flues into the proper regenerator, and means for retaining a proper draught through the cooling-flues to at once ensure their proper action and a proper supply of air to the regenerators." Fig. 1 is a sectional elevation taken through a bank of furnaces provided with regenerators and cooling-flues—the section being taken in the rear of the transverse flue J, as (for instance) on the irregular line at the left of fig. 2. Fig. 2 is a plan view, showing the ends of two adjacent banks of coke-ovens.

Fig. 1.

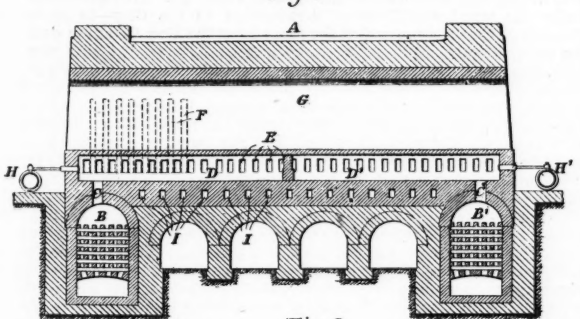


Fig. 2.

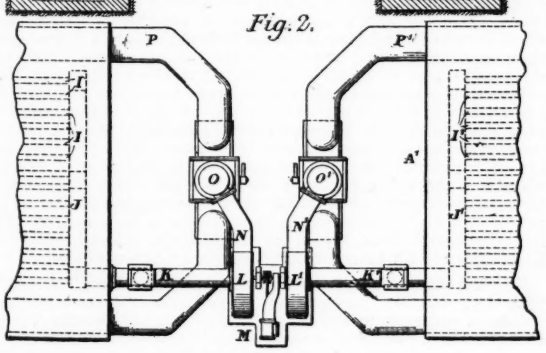


Fig. 3.

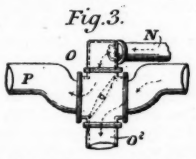


Fig. 3 is a sectional view of a valve by which the air from the cooling-flues is brought to each bank of ovens, and out of the other regenerator into the slack.

A A^1 indicate banks of ovens; B B^1 regenerative chambers situated in the front and rear of each bank and connecting through passages C C^1 with the combustion chambers D D^1. In fig. 1, the combustion chambers connect through flues E with vertical partitions, indicated by the dotted lines F, which, in turn, are situated in heating-flues extending between each adjacent pair of ovens. The view of fig. 1 is taken through one of the ovens, indicated at G. H H^1 are mains supplying gas to the combustion chambers through burners. I I indicate cooling-flues formed in the masonry beneath the ovens or furnaces and combustion chambers. These flues are usually open at one end, and connected at their other ends with vertical chimneys or flues leading out of the top of the masonry bank, and which maintain a draught through the cooling-flues. The flues I may be led into the common collecting flue J or J^1, from which, in turn, lead pipes K K^1, connecting with suction fans L L^1. N N^1 are discharge-pipes of the fans which lead to a valve-chamber O or O^1, in each of which is a butterfly-valve, as shown in fig. 3. With the chamber O are connected the conduits P leading to the lower part of the regenerative chambers B B^1 of one bank of ovens; and with the chamber O^1 are connected the conduits leading to the regenerative chambers of the other bank.

In operation, the fans L keep a constant current of air passing through the cooling-flues, which are freely open to the atmosphere at the ends opposite to those terminating in the common flues J J^1; and too energetic cooling of the masonry bank is avoided by admitting cool air in such quantity as may be desirable to proportionately diminish the flow through the cooling-flues I, and the adjustments of the valve, indicated in fig. 3, will cause the hot air to pass through the valve-chamber and thence to the regenerative chamber B or B^1 as desired.

CORRESPONDENCE.

[*We are not responsible for the opinions expressed by correspondents.*]

Gas Institute Visit to Paris.

SIR,—The Council desire to announce that a sufficient number of names having been received, the visit to Paris in connection with the forthcoming meeting of the Gas Institute, will take place in accordance with the notice issued to the members. At present, the respective number for each route—Dover-Calais and Newhaven-Dieppe—is about equal.

It has come to the knowledge of the Council that there are still others who wish to accompany the excursion, but who have not yet returned the reply form; it being impossible for them to say with certainty, so long beforehand, that they would be able to go. Messrs. Cook have therefore been asked, and have consented, to extend the time for the receipt of the final list of the party to May 30, *which is the very latest possible date they can offer*.

Members to whom this notification applies, are requested to send here their names, and those of friends (ladies or gentlemen), without delay; mentioning the route selected, and remitting the requisite registration fee.

The Incorporated Gas Institute,
13, *Victoria Street, Westminster, S.W.,*
May 7, 1900.

WALTER T. DUNN,
Secretary.

Patent Law Reforms.

SIR,—In the article on the above subject in your last issue, you say the Institute of Patent Agents "condemn the German and United States systems of Patent Office procedure," and you express the belief that an "eminent authority objects equally to the issue of Letters Patent at an applicant's own risk," &c. These matters are doubtless debateable ones; but for the Crown to take fees from an applicant who deposits a specification containing the following claims is beyond question unjust:—(1) The idea is absolutely my own; (2) that it will clean out any wooden pipe, no matter how badly corroded; and (3) make it equal to new." I submit that surely the applicant's attention ought to be drawn to the matter, and at least an opportunity given to amend. Rule 16 seems to provide for this: "Any irregularity in procedure, which, in the opinion of the Comptroller, may be obviated without detriment to the interests of any person, may be corrected, if and on such terms as the Comptroller may think fit."

Your remarks as to the stamping of agreements can hardly be said to apply, as the Crown authorities have no hand in their preparation, whereas they have in specifications, and they "direct" that claims be made. "Suggestions" are submitted by the Patent Office officials to applicants as to the title; why not, therefore, as to claims?

161, *Albion Road, N., May* 2, 1900.

ARTHUR CLARKE.

Directors v. Auditors.

SIR,—The attention of my Directors has been drawn to the article, under this head, in your issue of 24th ult., which contains the following statement of proceedings at the recent meeting of this Company: "The majority of shareholders present supported the Auditors; but, by the aid of proxies, the Directors carried their point, and, moreover, obtained the dismissal of the Auditors from the service of the Company."

The Directors desire me to point out that the whole of that statement is absolutely untrue. The Auditors were rejected upon a show of hands only. Proxies were not used for the purpose.

The academic conclusions of your article—formed, as they are, upon the above false premiss—are equally erroneous.

The Directors refrain from comment upon the strange assumption running through the article in question—to the effect that, in a controversy between directors and auditors, the latter must necessarily be right and the former wrong—but request the favour of your insertion of this letter as a matter of simple justice.

Horseferry Road, S.W.,
May 3, 1900.

G. B. GLADDING, Secretary,
Golden Grain Bread Company, Limited.

[Upon referring to "The Times" report of the proceedings at the meetings in question, we find that, at the first meeting, held on the 3rd ult., an amendment to the motion to adopt the report of the Directors was moved, proposing the appointment of a Committee of three share-

holders "to investigate and report to the shareholders upon the differences which have so long existed between the Board and the Auditors," and that the meeting should be adjourned, pending such Committee's report. This was obviously a motion of "no confidence" in the Board, and was so opposed by them. The Chairman "afterwards put the amendment, which was carried on the show of hands, but was declared lost by the Chairman, who stated that the Directors had received proxies from 283 shareholders, representing 43,975 shares and 7223 votes." A poll was taken; and the result was subsequently declared by Mr. Gladding (according to "The Times" report) to be "that 16 shareholders—15 in person and one by proxy—holding 7951 shares and entitled to 1033 votes, voted for the amendment, and that 241 shareholders—11 in person and 230 by proxy—holding 45,217 shares and entitled to 7348 votes, voted against the amendment." Mr. Gladding now declares that our statement, that "the Directors carried their point by the aid of proxies," is "absolutely untrue." Perhaps he will furnish us with the correct figures as to the result of the poll. Those reported in "The Times" do not bear out his contradiction. As to the dismissal of the Auditors, that, as we were aware, was declared carried by 22 to 17. If, as appears, our account was taken to mean that proxies were used to obtain that dismissal, we can only express regret that our language was ambiguous. At the same time, we must observe that the apparent indignation of the Directors at being, as they imagined, represented as using proxies for such a purpose, is somewhat discounted by the fact that, according to the report before us, "the Chairman, in answer to a shareholder, stated that, if a poll were demanded, it would be his duty to use the proxies."—Ed. J.G.L.]

Local Authorities and the Price of Gas.

A correspondent writes: "It would be very interesting and instructive to know what the majority of the Local Authorities who own gas undertakings intend doing to meet the great increase in the cost of gas manufacture arising out of the enhanced cost of coal and other materials used. As you know, it has been customary to look to the gas undertaking for a good sum towards the reduction of the rates. Will the ratepayers now be willing to forego the benefit, and pay higher rates, or will the gas consumer be called upon to pay a higher price for his gas to still relieve Mr. Ratepayer?" Our correspondent thinks this is a question which could very well be ventilated through the medium of the "Journal."

PARLIAMENTARY INTELLIGENCE.

Gleanings from the Committee Rooms.

After an unusually long Easter recess, the Parliamentary Committees resumed work last Tuesday. The members of Mr. Oldroyd's Committee passed with good grace from their leisure to the uncongenial task of inquiring into the sufficiency or otherwise of the present system of gas examination in London, which is the question raised by the Gas Testing Bill of the County Council. The Committee sat three days; and looking back over the mass of evidence they heard, one cannot but sympathize with them in being called upon to judge a case of such an intricate nature. Before the vacation, the County Council set themselves to prove to the Committee the need for a change in the gas-testing arrangements in London by legalizing the use of the portable photometer; and last Tuesday the efforts of the Council's witnesses were directed to showing that the instrument in question is a trustworthy one. In trying to convince the Committee that, to ensure the consumers received gas of 16-candle power, an alteration was necessary, witnesses asserted that, when the portable photometer was used side by side with an ordinary photometer in a properly appointed testing-station, equivalent results were obtained; but when the portable photometer was taken to other buildings, serious lapses in illuminating power were discovered. Strange to say, the testimonials which were put in last Tuesday as to the good and reliable character of the portable photometer showed that gas tested by it in a private house and Board schools in the Gaslight and Coke Company's district were well above the standard. This was so in all cases, except in tests made on April 26, at a Board school in Clerkenwell. There the Gas Company had fixed up two portable photometers in adjoining rooms with the view of proving that the instruments would give variable results even in the same building. But Dr. Clowes, who, as the chief representative in this matter for the County Council, was invited to experiment with these photometers, obtained concordant readings within 0·09 candle—the average of several readings being with one photometer 15·25 candles and with the other 15·34 candles. But on the preceding evening, the Company had found a divergence of 2 candles in the results from the two rooms. On ten days between April 13 and 28, Dr. Clowes and his assistant made tests, contemporaneously or nearly so, in different rooms in a private house in the north-western district, and there was practically no difference in the illuminating power; the average of the trials being above 16 candles and some above 17 candles. Further tests in a Board school yesterday week gave similar results. The same evening Mr. Thomas Fairley, the Gas Examiner to the City of Leeds, made simultaneous tests with Mr. Dibdin at the Netley Street Board School, and obtained average readings with one photometer of 16·58 candles and with the other of 16·7 candles—a difference of only 0·12 candle. Then in different rooms of unequal size, the average readings were 16·42 candles and 16·43 candles. All this taken alone is a very good argument against there being any necessity for an alteration in the gas-testing arrangements of London; but when the figures are placed side by side with those given before the adjournment, they are truly perplexing.

The three witnesses who were examined on Tuesday in support of the Bill were Dr. Clowes, Mr. Fairley, and Mr. C. R. Bellamy, the Gas Examiner of Liverpool. It is the opinion of Mr. Fairley that the portable photometer will give results equally accurate to a fixed table photometer. There are points of peculiar interest about Mr. Bellamy's evidence. He has had several years' experience with the working of the portable photometer at Liverpool. Down to 1894, he found discrepancies between the results given by the portable photometer and the official testing-stations averaging something like 1·26 candles; but since 1895, the testings have been practically uniform. His experience in Liverpool, however, has been with a different instrument from the one proposed to be adopted in London; and, moreover, he finds that testing with it in six places in the city secures a fair average of the whole supply. It is evident that there is no likeness between Mr. Bellamy's practice and the conditions the County Council would impose on the London Companies. He was called to bless the Bill; but left the chair with condemnation of random photometry on his lips.

The honour of opening the attack on the Bill fell to the Gaslight and Coke Company; and their first four witnesses were, given in the order in which they were examined, Mr. G. C. Trewby, Mr. Corbet Woodall, Mr. Greville Williams, and Mr. W. G. Young. In form and substance, the evidence of all the witnesses was admirable and impressive. It was shown that in the Company's area there are fifteen testing-stations; and these are considered quite sufficient to safeguard the interests of the consumers—in fact, there is no other place in the world where the system of testing is so stringent as it is in London. At the fifteen stations, during the past five years, no less than 21,000 odd tests have been made. In only 16 have the Gas Examiners reported against the Company; and in all but two, the Company's appeals have been allowed. Any suggestion that the gas supply to the testing-stations is manipulated is indignantly resented; and Mr. Corbet Woodall regards as very offensive the clause in the Bill which provides that notices to the Company of tests by the portable photometer shall not disclose where such tests are to be made. There certainly appears to be some connection between this clause and the insinuation as to manipulation. Very naturally the discrepancies between the tests with the portable photometer and those made at the official stations are ascribed to the dissimilar conditions under which they were made, and to local causes; and tests made by the Company support this view. For instance, Mr. Young cited tests which he had made with two portable photometers, under identical conditions and taking all precautions, showing variations between ½ candle and 2 candles. He and the other witnesses emphatically declare that the portable photometers could not be relied on. Mr. Woodall made a good point when he said that some confusion arises owing to the want of a proper appreciation of what is 16-candle gas. It is a gas which, measured under certain express conditions, will give a light of 16-candle power; and the conditions can only be obtained at a properly equipped testing-station. Therefore, any departure from the prescribed conditions is objectionable to the Company. The witnesses made it clear that the Company have not any antipathy to the multiplication of the testing-stations, notwitwstanding the expense, if it is considered necessary to increase them; nor have they any objection to tests being made at the various works.

Very valuable was the testimony given by Professor Vivian B. Lewes, who attended as a witness on the Speaker's warrant. He had found that, under the worst conditions of distribution in the City—in an office situated at the extreme end of the main from the Bow Common works—the mean average illuminating power, taken day by day and year by year, was 15·6 candles, while at the testing-station the illuminating power was 16·6 candles. When the office was removed into a more favourable position—nearer the main pipe—the average illuminating power was 16 candles; while at the testing-station it remained at practically 16·6 candles. Although admitting that the portable photometer is in itself an excellent form of instrument, Professor Lewes deliberately says: "My own opinion is that the requirements, to obtain good results from it, are so delicate that you would have to come back to certified stations." The present system of fixed stations, he believes, practically secures the consumers; but testing-stations at each works would afford far greater security. If, however, the present Bill is passed, it will render absolutely necessary the enriching of the gas by at least 3 candles in order that, in cross mains in which the gas stands, it should hold up its illuminating value sufficiently to give 16 candles, when tested by the portable photometer. To obtain this extra 3 candles of enrichment, the Companies would have to expend at least 3d. per 1000 cubic feet on the gas, and the main part of this would undoubtedly fall on the consumer. Such are the weighty opinions of Professor Lewes. It is also, in Professor Dewar's judgment, impossible to make tests taken as a standard comparable with a test taken at a Board school or in any public building; and he supports the view that the present method of testing is the best practicable security to the consumer that can be desired. With Professor Dewar, the evidence for the Gaslight and Coke Company concluded. Mr. Pope's address to the Committee was well-conceived and powerful; and he whipped the County Council with their own rod, by pledging his clients to accept, if the Council liked to approach them, the arrangement existing at Liverpool, under which no penalties are inflicted, but information is given to the Company to enable them to remedy defects.

The last witness before the Committee adjourned on Thursday until yesterday, was Mr. George Livesey; and his evidence covered many questions pertinent to the inquiry. The obligation on the Companies to supply gas of 16-candle power as defined by specific tests he admits; and he shows how that illuminating power would be varied by a variation of the conditions under which the gas is tested. If such a system as the portable photometer is applied, the Companies, he assures the Committee, would not be safe unless they sent out gas of about 19-candle power. The effects of this would be endless complaints and an addition of £126,000 to the consumers' charges in the South Metropolitan Company's district. The enrichment of gas, the burners used by consumers, and the violation by the Board of Trade of the requirements of Parliament in connection with the appointment of the Gas Referees are matters which also came under his lash. In connection with the serious defections in illuminating power which Dr. Clowes and others found in the neighbourhood of the Bankside works, as testified to at the sittings before the holidays, and upon which there has been a good deal of comment, Mr. Livesey states that the County Council representatives had an idea beforehand of the fluctuating state of things existing at that station;

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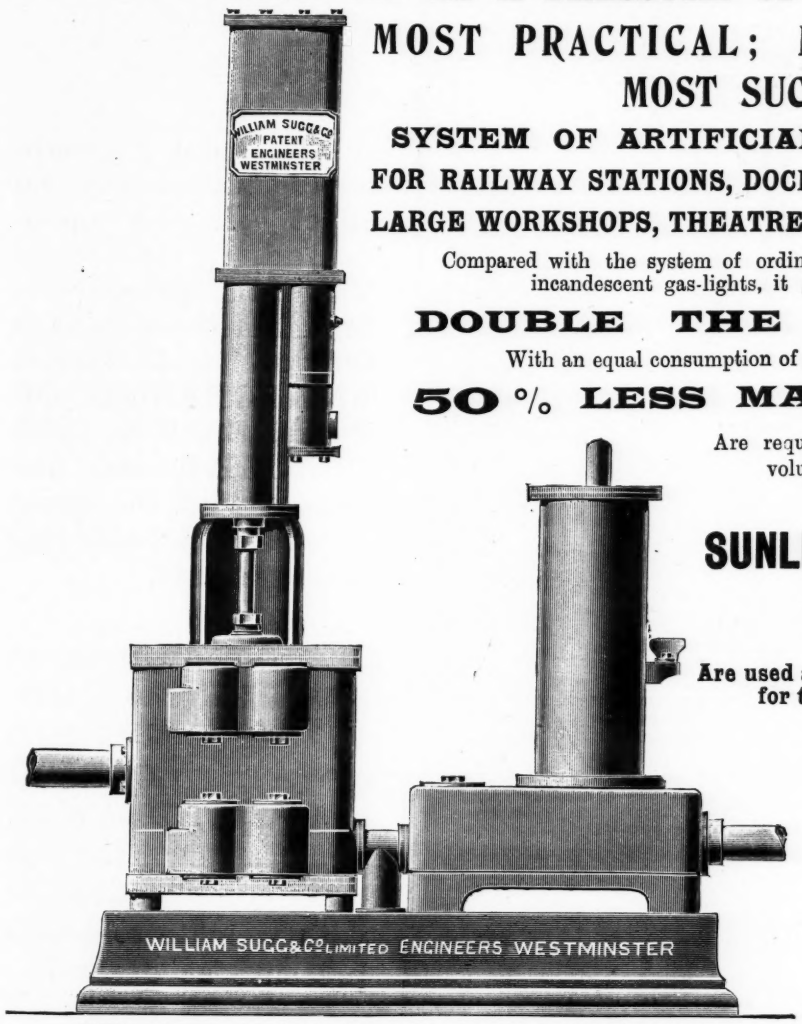

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FULL PARTICULARS ON APPLICATION.

VINCENT WORKS, WESTMINSTER.

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GAS GOVERNOR.

TESTIMONIAL FROM THE

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"Our Engineer has reported to the Directors that the Patent Equilibrium Station Governor which you fixed here last year, replacing one of another make, is giving every satisfaction, and maintains an absolutely regular outlet pressure under most trying conditions. We consider the open-ended Cylindrical Valve perfect, and a great improvement on the usual complicated construction of Equilibrium Governors, which are generally only balanced in one position of their range."

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and, like true sportsmen, they went where they were likely to meet with game. Much is expressed and explained in these few words.

[After hearing further evidence yesterday, the Committee declared the preamble of the Bill not proved so far as it relates to the testing of gas by the portable photometer.]

Municipalization is not by any means having all its own way in the Committee rooms this session. The wholesale absorption of neighbouring gas undertakings by Bradford, which most people thought a certainty after the expression of opinion by Lord E. Fitzmaurice at the close of the sittings of his Committee before Easter, is not to be accomplished yet. For the second time the Corporation have been told in connection with this matter, if not in such precise words, that "Parliament need not be expected to do anything except sanction that which the Corporation, by voluntary agreement with those concerned, have already in effect done for themselves." That is their real position. The Committee have accepted a clause providing for the transfer of the North Bierley Company's undertaking on the terms agreed upon before the Easter recess; but in regard to the Airedale, Eccleshill, and Clayton Companies, as no agreement has been arrived at, the Committee, without hesitation, have eliminated all the gas clauses from the Bill. Something in the nature of terms were negotiated with the Airedale and Clayton Companies by Mr. E. H. Stevenson, who was one of the expert witnesses for the Corporation; and what he did the Companies considered binding. But if a definite arrangement was made, it is clear that Mr. Stevenson exceeded his authority; and the Corporation straightway repudiated the finality of such a settlement. It is hardly credible that Mr. Stevenson with his experience can have overstepped the mark in this way; and no doubt the truth of the matter is that all he did was to negotiate terms which he felt he could recommend the Corporation to accept, and that the Companies were under a misapprehension as to the nature of his power and position in the matter. In connection with the North Bierley agreement, the Cleckheaton District Council made an effort to secure advantageous conditions in regard to the purchase of the portion of the concern in their own district, but failed; and they were likewise unsuccessful in obtaining the insertion in the Bill of a provision for equality of price within and outside the borough.

HOUSE OF LORDS.

The following further progress was made with Private Bills last week:—

Bills brought from the Commons, read the first time, and referred to the Examiners: Gas Orders Confirmation Bill, No. 1 (Abergele, Irthlingborough, Littlehampton, Mablethorpe and Sutton, and Romford Orders), Gas Orders Confirmation Bill, No. 2 (Dungannon Gas), Glastonbury Corporation Gas Bill, Maidenhead Gas Bill, Water Orders Confirmation Bill (East Surrey, Hayling, Maidenhead, Sevenoaks, South-West Suburban, and Tonbridge Orders).

Bill read a second time: Gas and Water Orders Confirmation Bill.

Bills read a second time and committed: Airdrie, Coatbridge, and District Water Trust Bill, Morecambe Urban District Council (Gas) Bill, North Warwickshire Water Bill, Southport Water Bill, Spalding Urban District Council (Water) Bill.

Bills read the third time and passed: Glyncorrwg Urban District Council Gas Bill, Hemel Hempstead Corporation (Water) Bill, Rugeley Gas Bill.

The Margate Corporation Bill and the Westgate and Birchington Water Bill were referred to a Select Committee, consisting of Lord Brougham and Vaux (Chairman), Lord De Manley, Lord Wrottesley, Lord Glenesk, and Lord Cranworth; to meet on Wednesday, May 9.

HOUSE OF COMMONS.

The following further progress was made with Private Bills last week:—

Bills read the first time and referred to the Examiners: Gas Provisional Orders Bill, No. 3 (Wath-upon-Dearne and District Gas Order), Glyncorrwg Urban District Council Gas Bill [Lords], Hemel Hempstead Corporation (Water) Bill [Lords].

Lords Bills read a second time and committed: East Stirlingshire Water Bill, Kingston-upon-Thames Gas Bill, Newtown and Llanllwchaiarn Urban District Gas Bill, Paignton Urban District Water Bill.

Bills reported, with amendments: Bedford Gas Bill, Bradford Corporation Bill, Newport (Mon.) Gas Bill [Lords], St. Albans Water Bill, Wolverhampton Gas Bill, Woodbridge Water Bill.

Dispute at the Newport (Mon.) Gas-Works.—A labour dispute has arisen at the Newport Gas-Works, owing to the introduction of "Rapid" charging-machines. The stokers and wheelers, of whom there are 24, did not take kindly to the new arrangement, and ultimately refused to use the appliances, although no one was displaced thereby. The Company, in the face of insubordination, paid the men off, and gave them a week's wages in lieu of notice; supplying their places with other workmen imported from a distance. The stokers received 35s. per week (eight hours per day), and the wheelers 26s. 3d., and about half-pay during illness. The police were guarding the works last week, in consequence of the fear of reprisals.

Gas Profits at Wigan.—The minutes presented by the Gas Committee at the meeting of the Wigan Town Council last Wednesday showed a profit on the gas undertaking for the past year of £14,078. The Chairman (Alderman Holmes) said, though the profits were good, the outlook was not so encouraging, as he believed that the Federated Coalowners intended to increase the price of coal 4s. or 5s. a ton. It would be a serious matter indeed, if the advance in coal should be carried to such an extreme as that suggested. Mr. Seagrave thought it was time the Council considered the question of reducing the price of gas. He saw it was proposed that the sum of £13,200 be transferred to the credit of the general district fund. He asked that the Committee should take this minute back, and consider what steps could be taken to reduce the price of gas. The minutes were eventually confirmed.

HOUSE OF COMMONS COMMITTEE.

Tuesday, May 1.

(*Before Mr.* OLDROYD, *Chairman, Mr.* EMMOTT, *Mr.* NICOL, *and Mr.* STANLEY LEIGHTON.)

THE GASLIGHT AND COKE, COMMERCIAL GAS, AND SOUTH METROPOLITAN GAS COMPANIES BILL.

The Bill promoted by the London County Council to make further provision with regard to testing the illuminating power of the gas supplied in the Metropolis, and to confer power on the Board of Trade to regulate the charge for, and the supply of, prepayment meters and fittings, which came before the above-named Committee before the Easter recess (*ante*, p. 937), was further considered by them to-day.

Mr. WORSLEY TAYLOR, Q.C., Mr. TALBOT, and Mr. B. WILKINSON, appeared for the County Council. The other Counsel engaged were: Mr. LITTLER, Q.C., and Mr. H. A. RIGG, for the Corporation of the City of London; Mr. POPE, Q.C., Mr. CLAUDE BAGGALLAY, Q.C., Mr. DANCKWERTS, Q.C., and Mr. R. J. NEVILLE, for the Gaslight and Coke Company; Mr. LITTLER, Q.C., Mr. BAGGALLAY, Q.C., and Mr. SNAGGE, for the Commercial Gas Company; and Mr. BALFOUR BROWNE, Q.C., Lord ROBERT CECIL, Q.C., and Mr. L. W. S. ROSTRON, for the South Metropolitan Gas Company.

Dr. *Clowes*, re-called and examined by Mr. WORSLEY TAYLOR.

Witness handed in a diagram showing the fluctuations in the illuminating power of the gas supplied by the London Companies during his term of office (which dated from 1897), in continuation of the diagram supplied to the Committee by Mr. Dibdin. The diagram showed that, at the time Mr. Dibdin left office, the illuminating power of the gas of the Gaslight and Coke Company was 15·1 candles. At the end of 1897 it had risen to 15·7 candles; at the end of 1898 it had fallen to 15·3 candles; and at the end of 1899 it had fallen to 15·2 candles. In all these years, the illuminating power was below 16 candles; and it had fluctuated in amount. In the case of the Commercial Gas Company, when Mr. Dibdin left office the illuminating power of the gas was 15·7 candles; at the end of 1897 it had fallen to 14·3 candles; at the end of 1895 it had risen to 15 candles; and at the end of 1899 it had fallen to 14·7 candles. In the case of the South Metropolitan Company, at the end of Mr. Dibdin's term of office the illuminating power of the gas stood at 14·9 candles; at the end of 1897 it had fallen to 14·6 candles; at the end of 1898 it had risen to 14·75 candles; and at the end of 1899 it had fallen to 14 candles—the lowest on record.

By Mr. POPE: He had worked out his diagram in precisely the same way as Mr. Dibdin had worked out his.

Mr. WORSLEY TAYLOR said he believed that experiments had been made during the parliamentary recess; and he asked witness whether it was not the fact that one or other of the Gas Companies had suggested to him that they were going to make tests with the portable photometer, and had invited him to be present.

Witness replied in the affirmative. He had received the following letter:—

The Gaslight and Coke Company,
Horseferry Road, Westminster, S.W.,
Dr. F. Clowes. April 26, 1900.

Dear Sir,—We have been making tests with the two table portable photometers at two of the Board Schools, and for the last two nights at the Board School in Compton Street, St. John's Road, Clerkenwell, with the result that the two photometers placed side by side in one room agree, and removing one of them to another room in the same building the results are very different. I write to ask whether you would like to witness the tests again to-night, or whether you would like to send a representative. The testings so far go to show that without having a room properly arranged considerable variations will take place in the results.

I should be glad to know by bearer whether you or your representative will be able to attend at the above school to-night. We should be quite ready to commence testing at 8 o'clock—in fact, our people will be there certainly not later than 7.—I remain, yours faithfully,

(Signed) G. C. TREWBY.

Mr. WORSLEY TAYLOR: There is a suggestion that this portable photometer is not to be relied on?

Witness: Yes.

What did you therefore do?—I went to the place where the experiments were being made, and found two portable photometers placed in similar positions in two large adjoining rooms in the school. In one of the rooms the windows were all closed, and in the other the windows were all open. At my request, the windows were closed, so as to bring the two rooms under precisely similar conditions. On examining the instruments, I found that there were small alterations desirable as to fittings. The gas was brought from pendants to the table by means of metal composition tubes, commonly so called. But this tubing was connected with the pendants and photometers by india-rubber joints; and in the case of one photometer, the tubing was joined by means of rubber. That is a state of things not allowed in fitting a photometer, as it is thought that gas loses a certain amount of illuminating power by coming in contact with india-rubber. I do not lay much stress on this, as I do not think that the use of the india-rubber affected the result very materially. Both the photometers were fitted in the same way. We should never allow such a form of fitting in the case of our own photometers. I requested that I might be allowed to carefully examine the adjustment of each of the instruments, because the results depend very largely on the accurate adjustment of the apparatus; and I was permitted to do this. I found the adjustment of one of the instruments satisfactory, and that of the other satisfactory save that the standard burner was going to be used in a condition which I could certainly not approve of.

Asked to explain the condition to which he took exception, witness said that the distance of the chimney of the standard lamp from the burner was distinctly too great. The Gas Referees furnished a little block of wood of the right height to measure its space; and after the chimney was adjusted, this block of wood must pass through the space, rubbing considerably against the burner and the bottom of the chimney. In the condition in which he saw the burner fitted, the block of wood would have had considerable play, which would make a great difference

in the value of the standard flame. He had called attention to this, and had got a proper adjustment made. He was then asked what programme he wished to adopt. Witness suggested that he and Mr. Grimwood should carry out the tests, take a series of readings with one of the photometers, and that the representatives of the Gas Company should simultaneously carry out tests with the second photometer; and that then they should change places. This was done. The first test was made at 8.45 with No. 1 photometer; and the corrected illuminating power, which they obtained as the average of several readings, was 15·25 candles. At 8.52, he moved to No. 2 photometer in the other room, and obtained a corrected average reading of 15·34 candles; the difference between the readings of the two instruments in the two rooms being 0·09 candle, which came well within the variation due to two different people reading instruments.

Mr. Worsley Taylor: Substantially, then, we may say the two, read as nearly as possible at the same time, gave the same results?

Witness: Yes.

Does this confirm your opinion as to the portable photometer being a trustworthy agent?—Absolutely; it simply confirms our previous experience.

A fair means under fair conditions of testing gas?—Yes.

I think Mr. Grimwood, your assistant, who has had great experience in these matters, and you jointly have carried out a further series of experiments, somewhat on the lines suggested by one of the Companies—that is, you went into a private house and tested with a portable photometer in, I think, three rooms in the same house?—Yes; the dining-room, a bed-room, and the garret.

And seeing, so far as you could, that the conditions were reasonable?—That is so. The house was No. 41, Lady Margaret Road, N.W., in the Gaslight and Coke Company's district. The gas was taken from pendants in the room, by means of wholly metallic connections. The experiments were made on April 13, 14, 15, 16, 17, 18, 21, 23, 27, and 28.

What, shortly, is the result, as showing that the portable photometer is to be relied on to give similar results under what I call similar circumstances?—I will give the differences between contemporary readings in two rooms. On April 13, a series of readings were made in the dining-room and bedroom, very nearly contemporaneously, and the difference was 0·11 candle. On the same day, tests were made in the dining-room and bedroom; and the difference was 0·02 candle. On the 14th, dining-room and bedroom, difference 0·04 candle; on the 15th, dining-room and bedroom, difference 0·06 candle; on the 15th, dining-room and bedroom, difference 0·07 candle; on the 16th, dining-room and garret (a little room with a sloping roof, hardly suitable for testing purposes), difference 0·11 candle; on the same day, dining-room and garret, difference 0·14 candle; on the 17th, dining-room and garret, difference 0·03 candle; on the 18th, dining-room and garret, difference 0·01 candle; on the 21st, dining-room and garret, difference 0·08 candle; and on the 21st, dining-room and garret, difference 0·32 candle—this figure being the largest difference obtained. On the 23rd, tests made in the dining-room and bedroom showed a difference of 0·12 candle; on the 27th, dining-room and drawing-room, difference 0·01 candle; on the 28th, dining-room and drawing-room, difference 0·01 candle; and on the same day, dining-room and drawing-room, difference 0·09 candle.

To sum it up?—We say there is practically no difference.

The Chairman: Can you state what was the average candle power at these trials?

Witness: I can only give it you roughly. It would be something over 16, I think; some are over 17.

Mr. Pope: Can you give the state of the gas at the testing-station at the same time?

Witness: Unfortunately, the testing-station in this district was closed. The tests were simply made to see if there was any difference in the value of the gas in one room as compared with what it was in another—not as to the absolute value of the gas.

Mr. Worsley Taylor: To see whether the portable photometer was to be relied on.

Witness: Yes; in different rooms. Continuing, he said that on the previous night (April 30) he made some further tests, the general result of which was similar to others already made. They were tests with the same photometer in different rooms of a board-school.

Mr. Balfour Browne: Suppose darkened walls are necessary for testing. In none of the three rooms had you that?

Witness: We had what practically amounted to a darkened wall. We had a special black screen in the direction in which we were looking. Sometimes we had the black screen; in other cases we abolished it. We found there was no difference.

Supposing I am right in suggesting there may be something in a wet meter or dry meter, whatever gas you tested in that house was open to the same difficulty about that matter?—I should say so.

Have you tested gas in an ordinary testing-station with an ordinary photometer, and tested gas from the same mains in an ordinary consumer's place with a portable photometer; and can you tell us the difference in the gas?—Yes. We have tests made at the same time, on the same night, in the same district, in a house adjoining the testing-station.

But not necessarily from what you have ascertained to be the same make?—We can only say they are close.

By Mr. Baggallay: He was not aware that the Gas Companies were required by statute to keep maps, open to the inspection of anyone interested, of mains throughout their districts. He did not know that if he had wished to know whether the two tests he was taking—one in a testing-place, and the other elsewhere—were from the same main, he could have obtained the information. He had understood from his predecessor that it was practically impossible to get such information; and he never tried. He was informed that in some cases, although he presumed he was working with the same gas, he was not.

Mr. Leighton: Did I understand that the Gas Company reported to you that they made experiments and found different results in the same rooms in the same house?

Witness: In the same school.

Then you went with the representatives of the Company to this board-school, with the results you told us?—Yes.

They made tests with the same instrument at the same time?—Yes.

Were they the same?—They give the results a little higher—the difference was again trivial.

When they tested gas with you, they found the same result in the different rooms in the same house?—Practically. I think they will acknowledge that.

But it had been different, when not with you?—On the preceding evenings there was a difference, I think, of 2 candles.

Mr. *Thomas Fairley*, examined by Mr. Wilkinson.

Witness said he was Gas Examiner to the city of Leeds. He had had experience in the testing of gas with photometers of both the old and new type, and also with the portable photometer. As a result of his experience, he considered the portable photometer gave results equally accurate with the fixed table photometer. On many occasions he had accompanied the witnesses who had given evidence on their visits to board-schools, and had himself checked the tests they had made with the portable photometer. Tests were made the previous night (April 30) at Netley Street Board-School, some little distance north of Euston Road, which, he believed, was in the Gaslight and Coke Company's district of supply.

Mr. Wilkinson: Will you tell the Committee the results?

Witness: We had two table portable photometers in the same large school-room on the ground floor. Mr. Dibdin and I made tests, and checked each other's work; and we took the tests between 8.40 and a little after 9 p.m. Simultaneous readings by Mr. Dibdin and myself gave 16·38 and 16·48 candles; the second reading, 16·63 and 16·54 candles; the third reading, 16·73 and 16·79 candles; and the fourth reading 16·59 and 16 99 candles. The last two were the only pair where the times were not simultaneous; there was 15 minutes' interval.

The greatest difference between the readings of the two photometers was one-tenth of a candle?—About that. The average of the whole four readings in each case was: Photometer A, 16·58; Photometer B, 16·7—a difference of 0·12 candle.

Then you proceeded to take tests with two photometers in two different rooms?—Yes; we removed Photometer B upstairs into a small room not one-fifth of the size of the other. The simultaneous readings were: Photometer A 16·46, B 16·30; A 16·36, B 16·46; A 16·43, B 16·70. The average of photometer A was 16·42, and of B 16·43 candles.

Did you take any precautions about testing the accuracy of the two instruments which you used, so as to make them exactly alike?—We tested every part of the apparatus each time it was set up; and when we moved the photometer into the upper room, we tested it all over again.

So that you are perfectly convinced the two instruments were the same?—As near as we could tell.

Mr. Pope: I do not understand you to have tested for the quality of the gas, but simply to show that, as between the two instruments in different rooms, there was practical identity?

Witness: That was all; the quality of the gas was all right.

Is it not a fact that they do not allow this portable photometer in Leeds, but that the tests are made at the works?—At the works and at my office at any time of the day or night. The portable photometer has not been proposed to be used. In the last two or three months, the gas at Leeds has not been quite up to 18 candles, because of the difficulty of procuring cannel coal.

You say the gas is tested at testing-stations and at your office?—Yes; and sometimes at my house.

Are the testing-stations at the works?—No.

Is not your statutory obligation to supply 18-candle gas at the works?—It may be so.

Mr. Emmott: You say you have tested at the stations, at your office, and then sometimes at your house. Have you found any material difference between the one place and the other at any time?

Witness: Not exceeding $\frac{1}{4}$ candle or thereabouts.

Nothing to make you suppose that there was any difference owing to the fact of the gas having travelled from the works to your house, wherever that may be?—That is so.

Mr. Leighton: How many testing-stations are there in Leeds?

Witness: Three. The gas supplied throughout the district—a very large one—is not tested in the district. As supplied in the district, it might be different from that supplied at the stations.

The Chairman: You have had experience with this portable photometer, and you believe it is as accurate as the ordinary bar photometer?

Witness: Yes. My office is about 1 mile, and my house 2 or 3 miles, from the works.

And notwithstanding this considerable distance, you find the tests the same?—About the same.

Taking the differences over a period of time, you did not find any difference between the tests at your own house 3 miles away and at your office 1 mile from the works, which might lead you to suppose that the gas either gained or lost in its illuminating power in the process of travelling?—They are practically the same.

Mr. Leighton: Do you enrich the gas?

Witness: With cannel. We are now proposing to use benzol.

Mr. Nicol: The Corporation have not asked you to select areas in Leeds to set up testing-stations for your own guidance?

Witness: No.

Then the tests that you have taken at your own house and at your office are personal tests, for your own guidance?—Yes; but I report my results to the Corporation, and where I find the gas below the standard, I report immediately—in the same hour.

You do not take tests at other places besides your house or office?—Occasionally. I do not attend myself.

You have stations?—Yes.

And officials under you who go to these stations?—Yes. Over the whole area of Leeds, there were three stations, situate about a mile from the works. Each was generally supplied from two works—possibly from three; and the power of the gas at these stations was 18 candles—sometimes over and sometimes under. One of the photometers at Leeds had been used as a portable photometer; for all ordinary tests the bar photometer was used.

Mr. *C. R. Bellamy*, examined by Mr. Talbot.

Witness said he was Gas Examiner to the borough of Liverpool, which office he had held for 18 years. He had had considerable experience in gas-testing in Liverpool and other places; and, in his judgment, such tests at fixed places and at fixed times were not sufficient to secure to the consumers the quality of gas required to be supplied by statute. In

Liverpool, the standard of illumination fixed by law was 20 candles, with an ordinary batswing or fishtail burner; and the testing-stations had to be 1000 yards from the works—such stations being under the joint control of the Corporation of Liverpool and the Gas Company. There was only one official statutory testing-station. There had been practical difficulties connected with the joint control. By an arrangement between the Corporation and the Company, a room not actually an official room was used; and joint control was interpreted to mean that each party should have a lock to the door. As a result, the station was used only twice in twenty years. There were loud complaints in Liverpool as to the illuminating power of the gas; and he had therefore made tests in different parts of the borough by means of a Dibdin portable photometer. He had found that in this way different results were obtained to those secured at the fixed testing-station. The procedure adopted in Liverpool was based to a large extent on Mr. Dibdin's experience in London. A Special Committee of the Corporation of Liverpool were appointed to deal with the matter; and they ordered different tests to be made by means of the portable photometer at certain public buildings throughout the city. The results obtained did not agree with those secured at the fixed stations.

Mr. TALBOT: As the outcome of that, a proposal was made, I think, that there should be additional testing-stations set up?

Witness: Yes.

And the Company objected?—They did not exactly object; but there were negotiations, and in the end an agreement was arrived at by which portable photometers were adopted. The portable photometer tests were not in way substituted for the official tests; but it was arranged that the Corporation should get information as to the illuminating power of the gas, and report to the Company as to the results obtained. The Company said, in fact: "We are anxious to comply with our statutory obligations, and you shall make tests with the portable photometer; and if you find that the gas is not of the proper quality, you shall report to us, and we will inquire into the matter and do our best to rectify the deficiency." Down to the end of 1894, the discrepancy between the portable photometer tests and the official tests continued. The discrepancy averaged something like 1·26 candles; and this was communicated to the Company.

What happened in 1895?—The two kinds of testings practically agreed. Those at the central office were about 21 candles, and those by the portable photometer 20·77 candles. Since then the results have been—

Year.	Official Photometer.	Portable Photometer.
1896	20·96	20·75
1897	20·83	20·68
1898	20·41	20·69
1899	20·74	20·72

In one year, you will see the portable photometer test showed better gas by about ¼ candle than that shown by the official test.

How were the tests made?—At any public buildings that were available. Suitable rooms were selected for the purpose; regard being had to proper ventilation and other conditions.

The result was that you found gas of substantially the same illuminating power circulating all over Liverpool?—Yes.

Do you find that the Company have any objection to your mode of testing?—None whatever. We have made our reports, and they have been accepted by the Company. Our length of mains is about 1000 miles. The Company's Engineer had expressed himself as thoroughly satisfied with the results of the system of testing adopted.

What was the maximum distance from the works of the places selected for the tests?—3½ miles.

Have you read the Bill before the Committee?—Yes.

Do you think it would be difficult to work such a Bill properly?—No. I see no difficulty in adopting a portable photometer; and I base that opinion on my experience in Liverpool.

Cross-examined by Mr. POPE: By an Act of 1865, the Liverpool Gas Company were bound to supply gas of not less than 20-candle power. In 1894, the Company agreed to the use of the portable photometer, though they could not come under any liability in regard to testing other than at the official testing-station.

Mr. POPE: And since then the system has gone on in Liverpool without complaint on the part either of the Corporation or Company?

Witness: That is so.

What photometer do you use?—The Dibdin bar photometer.

Your experience is based upon a different photometer to that suggested for use here?—Yes.

Mr. POPE: You tried the one proposed and found it unsatisfactory?

Mr. TALBOT: There is no "proposed" photometer.

Mr. POPE: Well, the one exhibited downstairs.

Witness: I tried a portable photometer, and did not get satisfactory results from it, comparing it with my own photometer. We use the bar portable photometer with batswing or fishtail burners, such as our customers use, but made with the greatest care.

All you say is that at Liverpool a particular portable photometer has been used, but not the one we are discussing now?—I have had no experience of the photometer discussed here. But the one sent to me, to which I have referred, was not the one that it is proposed to use in London.

You do not endorse the proposed method of testing?—I have had no experience of it.

The photometer that you returned in June, 1899, as unsatisfactory was the very one used by the County Council for their experiments, was it not?—I cannot say.

Cross-examined by Mr. BAGGALLAY: The deposit of naphthalene in the mains decreased with the rise of illuminating power. Of course, if there was a deposit of naphthalene, there was an effect produced on the illuminating power of the gas. They got a little naphthalene in Liverpool; but he could not say whether, if they increased the illuminating power of the gas, they would get more.

Cross-examined by Lord R. CECIL: The Corporation of Liverpool had a converted Evans photometer and a photometer by Wright and Co., of London, at their testing-station; and they also had a portable photometer. As a result of their experience, the Corporation selected about six positions where they usually tested, covering the whole area of the city; but from time to time he had visited a number of board-schools, fire-stations, and other public buildings, and made tests at them.

Lord R. CECIL: The six places you mostly use are known to the Gas Company, I suppose?

Witness: I do not know. We do not announce the places, and we change them from time to time. We usually make two tests at each place.

What was the nature of the complaints as to the quality of the gas in 1894?—The consumers complained of bad light, or want of light. Letters appeared in the newspapers on the subject, and others were addressed to the Corporation. There was a great deal of discontent on the part of the consumers.

What was the burden of the complaint—that the light was unsatisfactory, or that water gas was introduced?—Water gas was introduced at that time.

For enrichment?—No; I think not.

What for?—To take the place of coal gas—to supplement the supply.

It would be practically for enriching?—It could be used for that purpose. The public objected to the use of water gas. It is used at the present time, and without objection. It is sent out mixed with coal gas. At the time of the trouble, it was sent out without being so mixed.

Re-examined by Mr. TALBOT: All that the Bill provided for was the use of a portable photometer if the Gas Referees consented to its adoption. The Referees could insist on the use of a proper apparatus; and no doubt they would object to tests being made with such an apparatus as the one he had first tried at Liverpool.

Mr. NICOL: Is the portable photometer used in the area outside the city of Liverpool?

Witness: There really are no tests there.

In the use of the portable photometer in Liverpool, is there any arrangement between you and the Gas Company as to the distances from the gas-works and the places at which the tests shall be made, or as to the class of building in which the photometer shall be used for testing?—None whatever. The Company impose no restrictions.

And at no time is a representative of the Company present?—No.

So that the use of the portable photometer is entirely in your hands?—Yes; we use it when and how we like.

And you make a return to the Gas Company of the result of your tests?—Yes.

You do not test from house to house?—We have done that; but we do not make a practice of it. We test at about six places now.

And the testings you think give a fair average of the whole supply?—Yes.

Mr. NICOL (to Mr. Talbot): If the Company do not meet the complaints as to the quality of the gas, what liability is thrown on them—have the Corporation power to prosecute?

Mr. TALBOT: I should think not.

Witness: We have no power to prosecute under the terms of our arrangement.

The CHAIRMAN: The whole thing is a private arrangement.

Mr. POPE: Yes; quite voluntary, and not under statute.

The CHAIRMAN: And the London County Council are endeavouring to get such a system laid down by law in London as is working voluntarily in Liverpool?

Mr. TALBOT: Yes. We produce this evidence to show that the thing will work out in effect. The Corporation have power to go before the Recorder of Liverpool at any moment, and say that there ought to be further testing-stations.

The CHAIRMAN: I understand that it was on an application for the provision of further testing-stations that the present arrangement was entered into.

Mr. POPE: No additional testing-stations could be adopted while the present arrangement holds good.

Mr. NICOL: There is a penalty under the present Bill?

Mr. TALBOT: Yes.

Mr. NICOL: But there is none in Liverpool.

Mr. TALBOT: There may be a penalty exacted in connection with the tests at the official testing-stations. But in making the present arrangement, the Corporation wished to try peaceful methods before resorting to those of war.

Mr. NICOL (to witness): Did you make tests inside houses?

Witness: Yes.

How did these tests compare with those made in public buildings?—We have found no difference.

You have not made a test of the gas taken directly from the mains?—Not of gas taken directly from the mains, because we have had no means of doing that.

A MEMBER OF THE COMMITTEE: Do you find any difference in the test in the case of gas which has travelled a long distance from the works?

Witness was understood to reply in the negative.

The CHAIRMAN asked what was the method of enriching the gas practised in Liverpool.

Witness said they used cannel coal and oil.

The CHAIRMAN: I understand that the Liverpool Gas Company are renowned, if I may say so, for their liberal use of cannel coal?

Witness: That is so.

Have you sufficient knowledge of the manufacture of gas, having followed these experiments for many years, to speak as to the varying quality of the gas according to the distance travelled, or according to other peculiar circumstances which may be present from time to time?—According to my experience, the distance travelled does not affect the quality of the gas in any way.

Mr. TALBOT: That concludes the case for the promoters—at any rate, on this part of the Bill.

Mr. POPE: I now propose to put before the Committee the case of the Gaslight and Coke Company; and I think it would be convenient that I should call my witnesses before making any observations.

Mr. *G. C. Trewby*, examined by Mr. DANCKWERTS.

Witness said he had been with the Gaslight and Coke Company 35 years, and had been the first Resident Engineer at the Beckton works, which were the largest gas-works in the world. He had had special charge of the arrangements for testing the Company's gas; it being part of his duty to advise the Directors as to the testing arrangements. They had, he thought, ten or eleven manufacturing stations. These gas

making stations were mostly on the river, or on canals. There were fifteen testing-stations in the Company's area of supply, where the gas was tested every day. During the last five years, at these fifteen stations there had been no fewer than 21,000 odd tests made.

Mr. DANCKWERTS: In how many cases have the Gas Examiners reported against you out of that number?

Witness: In sixteen; but we appealed against the reports, and in all but two instances the appeals were allowed. After our gas is manufactured at the Beckton works, it is brought to London in 48-inch mains. The gas goes first from Beckton to Bromley; and then it passes round the North of London to Westminster. We have high-pressure mains.

I believe you have 21 miles of high-pressure mains. What is the object of high-pressure mains?—To get a larger quantity of gas over the mains into the gasholders, whence the gas is distributed through low-pressure mains. We work three shifts of men eight hours at our works. It is our object to get the illuminating power as uniform as possible; and that is the system we adopt at all our stations. At Beckton and some other stations, the ordinary enrichment for the gas is carburetted water gas, which is mixed with the ordinary coal gas. The mixing takes place in the works before the gas is sent into the holders from the high-pressure mains. By the Act of 1868, under which the Beckton works were constructed, only one testing-station was prescribed, and that was 1000 yards from the works. It was found some years ago that, after the gas had travelled 1000 yards, what was called the accidental enrichment was deposited, and the gas became of permanent quality; and that was why 1000 yards from the works was fixed upon as the position for the testing-station. At that time, however, gas was not manufactured on scientific principles. It is made on those principles now; and we find practically no difference in the quality of the gas in the works and its quality when it reaches a distance from the works. The photometer that we adopted originally was the Evans box photometer. Our Act does not mention any kind of photometer; but that was the one in use at the time the testing provisions were decided upon. That photometer remained in use till 1886, when the Referees prescribed a new form to be used at the new testing-stations. The Act of 1868, I should say, was the first Act which appointed the Gas Referees. There were to be three Referees, impartial persons, one of whom was to have had a personal knowledge of the manufacture and distribution of gas. As a matter of fact, among the three first Referees was Mr. Evans; but since his retirement, there has been no such person fulfilling the requisite qualification. Mr. Evans died twenty years ago; but he retired from the position some time before that. The Referees have power to prescribe the apparatus and the mode of testing. In 1876, we had an Act which laid down the new system, and that Act gives the Referees power to prescribe the number of testing-places. Under the Act of 1868, the hours of testing were laid down; but the Act of 1876 altered that arrangement. Under the latter Act, the Gas Examiners are to make at the testing-places daily such a number of tests as the Referees may prescribe. There is nothing whatever, as things stand, to prevent tests being made every minute during the twenty-four hours of the day. Before 1880, all the Metropolitan Gas Companies were under their own Acts as to testing; but in that year, an agreed Bill between the Companies and the Authorities was passed, and the system of testing therein laid down was that which is applicable to any Company, and which has already been spoken of.

Do you manipulate your gas?—Certainly not.

Could you do so?—No; we cannot.

Why not?—Well, take the case of Beckton. The gas supplied there is from one holder; and the gas must come out at one uniform quality at the mains. The mains are taken together to various points between Beckton and London, and in one uniform quality is delivered to the consumers.

In point of fact, does the same gas that is tested at the various testing-stations go to the consumer?—Yes.

Goes to him at the same time, in the same way, and under the conditions you have described?—Yes.

Every effort being made to keep it uniform throughout the twenty-four hours?—Yes.

Supposing you knew the time when the test was to be made, could you do anything to increase the illuminating power in readiness for that test?—Certainly not, as far as Beckton is concerned. At the other works, being nearer the testing-stations, it would be possible, in the course of a few hours, to raise the quality of the gas sent away; but it would take hours to do it.

In the present system, is there any necessity for the Examiners or Referees to give notice of the time of the test?—No. It was only in case of discrepancies that the Company asked to be allowed to make experiments at the same time.

Are your officers always present?—No.

Or do you ask to be present?—No. There were six stations for testing Beckton gas, the nearest being 7½ miles and the furthest 10½ miles from the works, and there were also testing-places for each of the other works of the Company situated at considerable distances from those works. There was difficulty in procuring suitable premises as testing-places, several conditions having to be considered—such as the absence of vibration, good ventilation with no drafts, and darkened walls—and it was also desirable to have the stations in communication with a live main, one where there was a regular flow of gas.

The usual thing is that the Gas Referees tell you to have a station, and you look out for one?—Yes.

And when you have found one, you ask them to come and inspect?—Yes.

I believe you are obliged by law to keep maps showing accurately your mains; and these maps are open to everybody, including the Gas Referees?—Yes.

When they approve of a place, they put a figure on your plan and thus know where the gas at that station comes from?—Yes.

You have no mains used for testing-stations and not for consumers?—Certainly not.

There is nothing on earth except the difficulty of obtaining the station to prevent the Referees from giving as many stations as they wish?—They prescribe as many stations as they think necessary to safeguard the interests of the consumers. Under statutory powers, the Company have a right to have a station of their own alongside the official station; and they have availed themselves of this right in three cases—at Dorset Buildings, Spring Gardens, and George Street, Hampstead Road.

What are the essentials of a room in which testings are to be made?—It should be perfectly free from vibration, by which I mean traffic, and it should be properly warmed and properly ventilated without any undue drafts. Then, another thing, which does not matter with the box photometer, but does with the new photometer, it is necessary to exclude all reflected light. That would not be merely secured by putting up a black screen in the direction in which you were looking.

Do you find as a matter of fact that vibration or ill-ventilation or variations from temperature and reflected light are liable to introduce error into the testings?—Yes; all that has been brought to my knowledge frequently by the testers who are from day to day in communication with me.

In connection with the pipe which brings the gas from the main into the testing-station, what precaution is taken?—The Referees in their prescription have laid down most completely what is to be done. The pipe is to be brought straight away from the main into the testing-room without communication with any other pipe; the object being to bring gas direct from the main up to the testing-place.

Is the pipe protected?—Yes; against frost.

Has the gas to be kept circulating freely in the pipe?—Yes.

I see that three of your stations are fitted as double stations—that is to say, supplies from two of your mains are brought into the same station. What is the reason of that?—I do not know. There is no reason why they should not test every day at each of these mains—in fact, we would prefer that they did so. Witness further explained that no testings took place from Friday to Monday; the result being sometimes that gas of low quality was shown.

There is a suggestion that there was a testing-place in Battersea prescribed by the Gas Referees in 1893 and not yet provided?—The Referees said they had this communication from the County Council. They asked us to furnish them with a plan of our mains, and we did so. They satisfied themselves that the same gas which they were asked to test at Battersea was passing over the bridge to the Carlyle Square testing-station on the other side of the water, and therefore they thought it totally unnecessary to put up another station, and cancelled their prescription.

What does the fact that tests by the portable photometer show illuminating power less than that at the testing-stations (having regard to your knowledge of the system of supply and that sort of thing, and the way in which your business is transacted) convey to your mind?—It conveys to my mind that the testings are possibly most of them made in the winter months, and that, from causes beyond our control, such as the service-pipe being exposed to cold, they may get different results at the consumer's premises than they do at the testing-places. Another thing is that the portable photometer, as far as our experiments go, unless under the same conditions as exist at the testing-stations, is likely to give discordant results.

So far as you can tell, have you any reason whatever to believe that the gas tested by this portable photometer is any different from that tested at the testing-stations?—None whatever. All the gas we send out must go to one or other of the testing-stations. There is no difference whatever.

So that any defect must be due either to the conditions under which the instrument is used, or to some local cause?—Yes.

The only three possible causes are: First, that something is wrong with the conditions under which the instrument is used; second, that something takes place between the main and the place where the gas is tested, owing to some defect in the service-pipe or something of that sort; or, third, manipulation. There is no other possible cause?—No.

You deny manipulation most emphatically?—Yes.

The Bill practically transfers the power of appointing testing-places from the Gas Referees to the Gas Examiners?—That is so, under the Bill as it stands.

Since the adjournment over Easter, have you had certain tests made?—Yes.

You have been assisted I presume by others?—Yes; by special outside and totally independent persons. In one case, at Lordship Park, the County Council put in evidence (but not verbally) as to the low quality of the gas. He had had tests made which showed that the gas there was fully up to 16 candles. This was at a small private house; and apparently the County Council made their tests after Jan. 31, 1899, between 10 and 12 in the daytime. The house was supplied from a 3-inch main; there being a service-pipe 40 feet long from the main to the meter, and about 24 feet more of pipe from the meter to the ground floor, where the test took place, so that there was nearly 70 feet of pipe for the gas to pass through, where all sorts of difficulties might occur. In a house of this kind, there would be a very low consumption of gas. The very same gas was distributed in London from Beckton, and was tested at Kinghorn Street, Dorset Street, and Spring Gardens, and found to be over 16-candle power, or nearly 3 candles more than the County Council test at Lordship Park showed it to be. On April 18, between 8 and 10 o'clock in the morning, he had tests made at the same place as the London County Council; and they turned out to be 16·73 and 16·66 candles. The testings at the official testing-station of the same gas was 16·8 and 16·2 candles. He attributed the result obtained by the London County Council to the accidental presence of some matter in the gas. Mr. Dibdin had handed in a table showing the differences between the official tests and the tests made by the portable photometer; but the Gas Company had not been able to discover any difference in the gas they had supplied. All their gas was tested before it left the works. They had the same tests at the works as there were at the stations; and these tests were made twice every hour. There were, in fact, persons at the gas-works doing no other work but testing; and owing to the precautions taken, the gas sent out from the works was practically of a uniform quality. He laid stress on the observance of precautionary measures as to ventilation, heat, reflective capacity of the walls, and so forth, in carrying out testing operations. So far as he knew, the Gas Referees had made no suggestion as to the adoption of portable photometers.

In regard to errors, what margin in the illuminating power of the gas would you allow in the case of the portable photometer?—I think 2 candles should be allowed—that is to say, 1½ candles in addition to the ½ candle allowed at the fixed station.

What do you work up to?—16½ candles.

You attribute the errors which occur in the testings made by means of the portable photometer to variations in the conditions of use?—Yes; variations in the conditions of the surroundings. I agree with Professor Vernon Harcourt that, under proper conditions, the portable photometer should give the same results as the photometer used at the official testing-stations and at our works.

How is the illuminating power of gas affected?—It is affected by the cold weather. We have had gas returned below 16 candles, especially when the service-pipe was long. In such cases, the naphthalene held in the gas is deposited. But when the weather has become warm, the naphthalene has been again taken up.

Do you see any reason why the existing testing does not guarantee to the public that the gas in the mains is of the quality you are bound to supply?—No; the conditions under which the official testing takes place are quite sufficient to safeguard the interests of the public. The fall in illuminating power is due to something that occurs after the gas leaves the mains—that is to say, to passing through defective mains or burners or other fittings. The deposit of hydrocarbons in cold weather not only impoverishes the gas, but there is another result. The hydrocarbons fill up bends in pipes, and prevent the gas flowing freely, with the result that the illuminating power of the gas is impaired. The free flow of the gas being impeded, less arrives from the main. Consequently, there is deficient pressure. As things at present stand, we have nothing to do with the service-pipes inside a building. The present regulations as to testing secure to the consumer gas of proper illuminating power up to the point at which our works end.

The Chairman: There is a lodgment of hydrocarbons in the bends of the pipes. Do they remain in the pipes, or are they re-absorbed?

Witness: Small deposits are re-absorbed when the weather becomes warm; but in the winter they sometimes have to be pumped. What one usually sees being pumped from gas-mains by a special instrument is moisture that collects in the pipes. Naphthalene sometimes has to be blown from the pipes back into the main.

Mr. Danckwerts: There is a special apparatus used for cleansing the service-pipes. (To witness:) Do you think that the multiplication of testing-stations would cover all the testing needed in the consumers' interests?

Witness: Yes.

Under your Act, the Referees have power to come to your works and inspect your gas at any time?—Yes.

And your Company are bound to give them and their servants access at any time?—That is so.

Suppose the Gas Referees had the right to bring testing-stations near your ten or eleven manufacturing works, they would know exactly what gas you sent out?—Yes. They would know whether it was below the illuminating standard. By planting testing-stations near the works, all opportunity to the Company of tampering with the quality of the gas to the detriment of the public would be prevented.

It has been suggested that the more testing-stations there are, the greater the expense to you. Would you be prepared to bear the expense for the sake of establishing a fair system of testing?—Yes.

You have no objection to any system of testing that is fair?—None whatever.

But if the travelling photometer were in use, you would never be certain that the testing would not take place under conditions which would indicate a decreased illuminating power?—That is so. Take the case put forward by the London County Council. The testing at Lordship Park had shown 3 candles less than the Company knew to be the illuminating power of the gas.

To adopt the travelling photometer would be to introduce a great element of uncertainty, would it not?—Yes.

And it would not secure the consumer?—It would not.

It would not give anything like the security that would be given by the system at present in force with a multiplication of testing-stations?—That is so.

Supposing you had, in order to meet any possibility of being saddled with a penalty, to raise your illuminating power 2 candles, what would that mean in annual expenditure?—If you calculate it at the rate of 1d. per candle, it would cost £190,000, which would have to be put on the price of gas, and increase the price to the consumer.

Mr. Nicol: Would you divide that figure between the consumer and the shareholder?

Mr. Danckwerts: According to some authorities, 4d. out of 5d. is borne by the consumer; according to others, it is 6d. out of every 7d. About £160,000 would fall on the consumer and £30,000 on the shareholder.

Witness: It would mean a reduction of the dividend of ½ per cent. Continuing, he handed in returns of the average illuminating power of gas supplied from the Company's works at the official testing-stations. The gas supplied from Beckton ranged from 16·6 to 16·2 candle power; and in the cases of the other works, both at the works and testing-stations, the averages were above the standard. The tests since the adjournment were on instructions witness gave; and they were made, among others, by Mr. Young (one of the testers of the City Corporation), who was entirely unconnected with the Company, except that he tested the Company's gas in the City. The tests proved that taking the same gas, under like conditions, one obtained side by side at times concordant results; but if one of the photometers was taken into another room of the same size, the result differed as much as $\frac{5}{10}$ candle. If the conditions under which the photometers were used were varied, the results varied correspondingly.

Cross-examined by Mr. Worsley Taylor: The Company had eleven manufacturing stations, each having a district allotted to it. There were small safety mains between one district and another, so that if (say) the pressure were reduced in one, a second could be connected to get the matter right.

Mr. Worsley Taylor: You would agree that these tests were designed in the interest of the consumer, with the object of showing that he shall have an opportunity of drawing 16-candle gas all over your district?

Witness: Drawing from a main supplying 16-candle gas in the area of our supply.

And all over that area?—Yes; practically. There are cases where you have small mains where at times you do not get 16 candles.

The object of testing is to see that this is ensured, and that the consumer may know it is ensured?—Yes.

If he does not get 16-candle gas all over, in that way, it is not right?—If he does not get 16-candle gas in our leading mains, he ought to get it.

You would have no objection to any system of testing with a view to ensuring that?—I consider the present system fair.

You are satisfied with the present system, because you say that it is fair between Company and consumer?—Yes; and very stringent, too.

You do not object to any fair system of testing with the view of securing the result that ought to be secured—16-candle gas?—No.

And you suggest that the testing-stations at your works, at your cost, would secure that?—Yes.

Have you any objection to tests being made at any time without notice?—None whatever.

Then you are perfectly willing that there should be a certain alteration in the present conditions of testing?—The Gas Referees have full power under the present statute of fixing testing-stations at the works.

A testing-station to test at any place and at any time?—Yes.

Supposing the portable photometer to be, in fact, a fair method of testing, you have no objection to it?—The photometer by itself is identically the same as in the fixed testing-stations.

You would not object to testing at other places than the fixed testing-stations if those places were fair?—If the rooms in which the testing was made and the conditions were fair.

Now then we are agreed: Instrument right, time right, another room right, provided the conditions in that room are right?—Yes; and the supply to the room is right. I mean, in order to test the gas properly, you must have the service-pipe brought from the main in strict accordance with what is laid down by the Referees. Witness objected to the provision of the Bill under which power was given to make a test "at any place." The place should be fitted up as a testing-station like the existing fifteen testing-stations. Without the whole of the machinery in the existing testing-places, a fair result could not be obtained. Witness was pressed to acknowledge that, having fixed the present testing-stations and the conditions there, the Gas Referees were competent to fix the conditions under which peripatetic tests might be made; but that he declared would be giving them too much power. If gas passed through a consumer's meter, even if the tester were satisfied as to the state of the meter, the result would be vitiated. Very often the consumer's meter was exposed; and probably, therefore, the result of the gas passing through would be that its illuminating power would, in cold weather, be diminished. The effect of temperature on gas did not seem to be very well known; even Mr. Vernon Harcourt did not seem to be aware of it. There were no data on which an adjustment could be made for a pipe being exposed. The question of ventilation was a very delicate matter; it could only be gauged by the test of the gas.

Do you say that you cannot go into a room to test the gas with the portable photometer and depend upon getting a test within ½ candle of the true illuminating power?—Yes. We have made experiments by going from one room to another, and have found as much as 1 candle difference between the results in the different places. We are confident that you cannot make a reliable test without having a room properly fitted up for the purpose.

You say deliberately that an expert cannot go into a room and state with confidence: "This is a room in which we can make a proper test?"—I have never met with such a man yet.

Are you acquainted with the result of the testing in Liverpool?—Yes; but it is of no statutory value. Even in the case of Liverpool, however, they have six testing-places; and I have no doubt that care has been taken to see that they are proper rooms. The system of photometry has altered during the past twelve months; and it is more important than ever to have the conditions of each of the testing-stations corresponding with those of the others.

You agree with Professor Vernon Harcourt on some points. Do you agree with him that the present system of examination at the stations is not so perfect a security for the public as it should be?—I think our arrangements are sufficient to safeguard the interests of consumers.

Professor Vernon Harcourt said it would be left to the Referees to prescribe the apparatus to be used, and the mode of using it. Do you agree with that?—I maintain that if you wish to take a photometer into a room for the purpose of making a test, you must adopt the precaution to fit that room up as a testing-station. I do not agree with what the Professor said as to the Referees being able to do that.

He said that the effect of the Bill would be to provide complete security for the consumer. Do you agree with that?—I do not.

Re-examined by Mr Danckwerts: He was certain the peripatetic photometer would not secure the consumer. It was a very uncertain method of testing.

By Mr. Emmott: He attached great value to the temperature.

Can you tell me the difference between a room where it is 52° and another where it is 60° with gas of the same quality?—It is difficult; but I should think it would make a difference of one candle. In cases where from some reason the Gas Examiner had not been able to keep up the temperature of the room, the results had been bad. In sixteen cases in which it was said the Company's gas was below the standard of illuminating power at the stations, there were appeals; and in only two cases judgment went against the Company. He could not give particulars of the cases.

Mr. Nicol: In reference to this peripatetic photometer, you admit that if the Gas Referees decided that more testing-stations were required, you would be quite prepared to meet the increased liability?—Yes.

Assume that authority was given to the Gas Referees to adopt the portable photometer, would you object to that, provided the place where the test was to take place was one which would meet all the conditions you have set out as necessary to give a fair return?—If they have rooms properly fitted up in the same way as the present stations are, to ensure perfect results, then it can be done.

All the difference would be that, instead of having a table photometer, you would have a portable photometer?—Yes.

Supposing that the supply was taken from the service-pipe, and the portable photometer was used in that room, which met with all the requirements you say are necessary to get a fair and adequate result, would you have any objection then?—Yes; it is highly essential that the gas should be brought up from the main in the same condition as it exists there, and to do that, you must have a special service-pipe.

Do you mean that the gas might be contaminated or have its illuminating power reduced between the service-pipe and the main?—Yes.

By the CHAIRMAN: He had heard evidence as to delay in securing the completion of a testing-station; but that was contradicted by Mr. Vernon Harcourt, who said he believed no undue delay had occurred.

The CHAIRMAN: You think that if the gas at the testing-station gives an illuminating power of 16 candles, it will do so universally over the district of supply?

Witness: Over the area of supply, except in the case of dead-ends, and so on. At all the Company's works the gas was tested before being sent out.

Do you find any difference between your tests there and at the testing-stations?—On the average, they agree.

Is the fluctuation much?—No; we endeavour to keep it as even as possible. The test at the works was as nearly as possible the same as at the testing-stations.

With this portable photometer, you think the uncertainties are so great as not to warrant its use in determining the quality of gas, the result of which might be a serious financial fine on the Companies?—Yes; that is our firm conviction.

That the photometer itself is not sufficiently reliable to be moved from place to place; and also that the conditions surrounding the photometer may vary so much as to make the test practically worthless?—Yes.

Mr. NICOL: You have stated that it was impossible for the Company, from its source of supply, at any moment, at any place or time, to either lower or raise the standard of the gas?

Witness: It would take a very long time to do it.

If it could be done, you have not attempted such a policy as that?—No.

To put it plainly, you have had no intention to deceive the Gas Examiner when he came on his rounds and took testings at the testing-places?—No; certainly not.

Mr. DANCKWERTS: Such a policy would be defeated by having a testing-station at the works?—Yes.

Wednesday, May 2.

Mr. *Corbet Woodall*, examined by Mr. BAGGALLAY.

Witness said until the amalgamation of the Phœnix with the South Metropolitan Company in 1880, he was Chief Engineer to the former Company. He was now a Director of the Gaslight Company.

Mr. BAGGALLAY: Would you tell the Committee your opinion as to whether any alterations in the method of testing the illuminating power of London gas are called for?

Witness: In my opinion they are not.

Are there defects which you are aware of in the present system of testing gas?—I think the present system is very excellently designed for securing the uniform supply of gas of the contract quality throughout London.

You used the word "contract." Would you explain what you mean?—The quality named in the Act of Parliament governing the respective Companies.

The contract which was made between the Companies and the public under the sanction of Parliament when the candle power was fixed and the sliding-scale and other matters, including the standard price, were arranged?—Quite so.

All these matters being considered prior to the legislation of 1876 by Committees of Parliament?—Yes; that is, I understand from you that the illuminating power of the gas was one element in the contract which included the price of the gas.

That was the 16-candle power at the testing-places, wherever, and as many as the Gas Referees might fix?—Yes. As the Committee are aware, the right to place testing-stations at any part of the district was an alteration from the original arrangement, under which the testing-place was to be as nearly as possible 1000 yards from the place of origin of the gas.

The CHAIRMAN: I should like to know whether, in this matter, you limit the Act to which you are now referring to the supply of 16-candle power gas to the testing-stations.

Mr. BAGGALLAY: Yes.

The CHAIRMAN: Is it not implied that the gas will be of the same quality when it gets to the individual consumer?

Mr. BAGGALLAY: I do not think so. Of course, it may be. The construction we put upon the Act is that the gas was to be 16 candles at the testing-place; the testing-places to be so situated as to make it probable that approximately 16 candles would be given throughout the area (except under exceptional circumstances of dead-ends, and so on) which that testing-place was supposed to govern.

The CHAIRMAN: And since then Parliament has given the Gas Referees the right of increasing indefinitely the number of testing-places, and locating them in any part of the district?

Mr. BAGGALLAY: Yes.

Witness: That has been so since 1876.

Mr. BAGGALLAY: The right would be exercised frequently.

Mr. NICOL: That 16-candle power was only over the service-pipe?

Mr. BAGGALLAY: Yes; we could not be responsible for what might be done with the gas after it left our pipes. (To witness:) Testing at the testing-place for the prescribed number of candles of illumination, I take it, is the universal law throughout the United Kingdom?

Witness: Yes.

In almost all cases there is only one testing-place provided?—In over 90 per cent. of the cases the tests are conducted at the gas-works.

London being a large area, you would naturally require more testing-places?—Yes. I think some confusion arises from the want of appreciation of what 16-candle gas means. It is not as if it were something that was always the same. The 16-candle gas is 16-candle gas under the express conditions laid down for testing. The kind of burner used may make a difference.

The CHAIRMAN: The details are all prescribed?

Witness: Yes.

They have to pass the Gas Referees?—Yes. The adoption of a proper burner, the regulation of the room, and so forth, are conditions which are essential to the realization of the standard 16-candle gas.

You act, I believe, as Engineer or Consulting Engineer in respect of some gas-works on the Continent?—Yes. I am Consulting Engineer to the Imperial Continental Gas Association, who supply a large number of the principal cities on the Continent.

Taking Europe generally, is there such a costly system of testing to be found anywhere as that which prevails in London?—There is not; neither is there any country where the standard of illumination is so high.

Even in the United Kingdom, except in London, there is no control of the testing by Gas Referees, is there?—No. There are Gas Examiners in most of the large towns.

Mr. BAGGALLAY: That is under the general law. If the company provide the gas, the local authority can appoint an examiner; and if the local authority supply the gas, five consumers can apply to the justices to appoint a person to examine it.

The CHAIRMAN: Does the witness throw any doubt on the efficacy of the examination. He says that 16-candle gas is a thing of uncertain and indefinite meaning?

Witness: I did not mean to convey that. It is a definite and clearly measurable quantity under the conditions laid down; but if you take the same gas and pass it through different kinds of burners, you can get the gas down to 8 candles, or even lower.

The same gas may differ as to illuminating power according to the way it is treated in the testing; but I suppose we are safe in the form of testing that has been adopted. We cannot imagine that the whole course of legislation has been proceeding in the dark?—Not at all.

The CHAIRMAN: I understand the point, and we will leave it now.

Mr. BAGGALLAY (to witness): You say the existing system is satisfactory?

Witness: Yes. It is a rigorous system. It only allows a very small margin for failure of illuminating power before penalties are incurred—only a 3 per cent. margin is allowed.

Have you considered the proposal of the Bill to allow testing to take place in other than certified testing-places?—Yes.

Unless you were certain of the conditions at the testing-place, could you be sure of your results?—No. The trials which we have made show that you cannot be sure of the results. It would be an extraordinary thing if, after all these years of patient development of the present method of testing, it turned out that all the precautions we have taken are unnecessary. To say that they are unnecessary would be a very flippant way of treating a system of testing which has been developed with great care during many years.

In your opinion, are the conditions—such as temperature and freedom from draught—necessary to ensure proper testing?—Yes; I know that they are from my own observations. Draughts that flicker the flame must affect the result. It is essential that you should have proper conditions as to the room, and also as to the method of abstracting the gas from the main. Deposits of hydrocarbons in small pipes affect the illuminating power; and over a large area, a great many small pipes have to be used. All this tends to affect the quality of the gas to a slight extent in testing for the illuminating quality. As a matter of fact, the variations in the quality of the gas over the whole area of the Gaslight and Coke Company are very slight, except under peculiar circumstances.

The CHAIRMAN: You say that the deposits in small pipes affect the illuminating power. Do you not think that the deposits in large mains would have the same effect?

Witness said the deposits in large mains would not be so material.

By Mr. BAGGALLAY: The number of testing-places required by the Referees had been increased whenever they had thought that another testing-place should be provided in the interest of the consumers. He did not know what the reasons had been which had led to this. The Referees had added to the number of testing-places from time to time as they thought necessary. They had asked for additional stations; and the Company, under the Act of Parliament, were bound to supply them.

The CHAIRMAN: How has the increase proceeded?

Mr. BAGGALLAY: I have not the details; but I know that two have been added in the last eight years.

Witness said that in Paris the testing-station was within 1000 metres of the works, and $\frac{1}{2}$ per cent. candle power was allowed for each additional kilometre.

The CHAIRMAN: That is about $1\frac{1}{2}$ per cent. per mile?

Witness: Yes. I point this out to show that depreciation of quality in relation to distance of supply is generally recognized.

Why is that?—There is a certain amount of depreciation of quality in a certain temperature. The hydrocarbons are thrown down at a low temperature; but these influences are slight.

Morally, do you say that the Company recognize their obligation to supply 16-candle gas?—I do, distinctly.

In reply to further questions, witness said the difference between the quality of the gas at Beckton and when it reached London was appreciable—from $\frac{1}{2}$ to $\frac{3}{4}$ candle.

The CHAIRMAN: Out of the seven stations connected with the Beckton works, we have only one that shows any decrease in the illuminating power as compared with the test at the works. The works test is 16·4 candles, and these are the figures following: Kinghorn Street 16·5, Dorset Buildings 16·4, George Street 16·3, Graham Road 16·4, Vincent Terrace 16·4, and Vinery Villas, 16·2. These are miles away.

Mr. NEVILLE: Those are averages during the whole year.

The CHAIRMAN: That does not alter my point at all. It is all the more accurate a test. If during the whole year the average has been 16·4 candles at the works, and then at one of these places, 6, 8, or 10 miles away, it is on the average about the same, or if anything above, it seems utterly inconsistent with the theory that gas loses a percentage of the illuminating power per mile. My point is that we have got no diminution at all. Of course, I admit it is under this high pressure, and that there is a very large volume.

Mr. BAGGALLAY: I was going to say it is almost like a gasholder. There is so little skin friction, owing to the large volume of gas and its high velocity.

Witness: I am sure the difference would be an appreciable difference in the gas sent by the minor distributing mains. I hope you understand I do not desire to place any importance or weight upon that. All I say is that provision is made for that; gas is sent out of sufficiently high quality to make up for that.

The CHAIRMAN: As a theorist, you say some diminution of illuminating power will take place?—Yes.

As a practical man, and as a representative of the Company who are now answering the case of the promoters, you say you do not wish to be bound down by this circumstance?—Yes.

In further examination, witness said that during winter the gas, as it passed through the mains, made deposits, which were taken up more or less in the summer; but even in summer time, there were sometimes deposits. The process of taking up the deposits was very slow. He had taken from mains many tons of naphthalene which would never have been absorbed under any circumstances. Naphthalene was deposited in some weathers, and then later on, under other conditions of temperature, evaporated. It might be that on the day when deposit took place the quality would be reduced.

Mr. Baggallay: It comes to this—that where you get a very large main with a high velocity and a constant current, the variation will be much less than in the smaller distributing mains where, during many hours of the day, the passage of the gas is slack, where elbows and joints are frequent, and where the proportion of skin surface to the amount of gas passing is great?

Witness: That is so.

As you go down in the size of your pipes, and you get into the distributing areas, you get much greater variations?—You do get greater variations.

In your opinion, are the existing testing-stations which have been fixed by the Referees well situated for control of the districts?—I think they are.

Witness handed in at this point a map showing the district mains, the high-pressure mains, and the testing-stations of the Gaslight and Coke Company. He had not seen the map before entering the box that morning; but it seemed to show that the Gas Referees had wisely located the testing-stations, which were placed so that, as far as possible, they should be on the leading mains from each of the works. The limitation of 1000 yards in regard to the testing-stations had not been adhered to. These places were fitted up under the direction of the Referees, and were inspected and passed before being used for testing.

Mr. Baggallay: You would have no objection, if it were thought proper, to alter the positions of some of the testing-places? You would see no objection to substituting other places, if it were considered right by the Referees?

Witness: I do not think any remonstrance has ever been addressed to the Referees with regard to the testing-stations.

If further tests were thought desirable, in order to be able to compare the exact condition of the gas as it left the works with the condition of the gas at other testing-places, do you see any objection to adding other testing-places at or near the works?—No.

Except as to expense?—Quite so. If some of these stations are thought to be badly placed they can be removed. After all, the cost of a station is not very much—about £200 a year.

The multiplication of testing-places like that would be nothing as compared with the increased cost that would be put on you to provide 16-candle gas at any place where the portable photometer might be taken?—That might be an enormous sum.

The Chairman: That would depend upon the efficiency of the photometer.

Witness: About the photometer there is no question whatever.

The Chairman: I mean the practical efficiency.

Mr. Baggallay: Assuming that the photometer were all right, and the conditions could be got all right, if you had to guarantee the 16-candle power at any point where a test might be taken, it would necessitate very great enrichment beyond what is now necessary at the works, would it not?

Witness: If I followed your question—No. If the photometer is all right, and the conditions at the testing-place are all right, I have said we already recognize our duty to supply 16-candle power gas.

What I meant was that you got the gas from a fairly active main, and not from one of these smaller places?—Certainly.

I want you to look at Clause 5 of the Bill for a moment. There is a paragraph that "No person shall disclose to such Company, by such notice or otherwise, the place at which any such tests are to be made." What do you take that to mean?—I am bound to say I regard it as a very offensive suggestion.

Is there any construction you can put upon it other than that it means they are afraid of your having notice, because they fear your tampering with the gas, or doing something which may affect the test?—I can see no other meaning to put upon it.

Have you in the past ever known or suspected any tampering with the gas which was being sent to any station for the purpose of testing?—Certainly not.

Have you any officer who you believe would be capable of such a thing?—We have not; and I say distinctly that if such instructions were given to the officers of the Company, I should expect from many of them that their resignations would be sent in rather than that they would carry them out.

Is it practicable?—With regard to the Gaslight and Coke Company, it is almost silliness. With so large a proportion of the gas brought up from Beckton, it is childish to suggest the possibility of doctoring the gas for the testing-stations.

Your gas, I think, has been tested in the City at all times?—I believe it has. At any rate, the Referees, the Examiners, and the County Council all know that we desire to exercise no supervision over the testing—that we are perfectly willing the gas should be tested as we test it ourselves. There are tests every hour and half hour at the works.

By Mr. Nicol: The testing in London was more severe than anywhere else; and because of that, it was necessary to keep constant watch on the gas, and make the tests at the works every half hour.

Further examined by Mr. Baggallay: The Company used a good many different qualities of coal, and so had to employ various enriching materials, and to test to see the result of different combinations. The bulk of the ordinary coal used did not produce 16-candle gas; so it had to be enriched to the standard, and beyond it, in order to make the gas perfectly safe.

Mr. Baggallay: So that to protect yourselves against the penal clauses of the testing Acts you have to keep up constant testing?

Witness: Yes.

Supposing there had been any deviation whatever which would justify those lines in that clause of the Bill, it was open, I take it, to those who suspected you to have applied to the Referees to ask for another testing-place near your works?—Certainly.

Which would have dealt with the whole matter?—Although it is quite new to me, it does appear to me that if testing-stations were established practically at the gas-works that would meet the case completely. But I say again, I see no reason whatever for any departure from the system as it now exists. Continuing, he said the evidence did not by any means support the clause. In several cases it had been admitted that some care would have to be taken in the selection of the places, and in the manner of fixing up the apparatus used. That was very different indeed from the claim made here, of power to test at any place at any time. Mr. Dibdin suggested that, in order to cover any chances of error or variation, an extra candle (three times the present margin) should be allowed as a margin before penalties fell upon the Companies. Such a suggestion was damnatory of the scheme submitted.

It shows that there are variations which they themselves anticipate, and for which they feel they cannot in fairness do otherwise than provide three times the margin they have at present?—It seems to me to confirm the view I take. It was a proposal to substitute a rule-of-thumb arrangement for a scientific arrangement.

Mr. Worsley Taylor said Mr. Didbin referred to an outside limit of a candle, not an extra candle.

Mr. Baggallay remarked that it did not matter, for the purpose of his argument.

Witness, further examined, said the suggestion was evidence of the necessity of further investigation by a specially constituted Committee able to make tests, as to the results to be obtained by a portable photometer before it was put upon the Companies, even though a *primâ facie* case might be made out. Absolutely no case had been made out with regard to the Gaslight and Coke Company, because Mr. Trewby showed that out of the enormous number of testings there were only two below the standard in which penalties were imposed. The question of standards was under consideration three or four years ago; and then a Committee were specially appointed by the Board of Trade, who made thousands of experiments before arriving at a conclusion.

Mr. Worsley Taylor, in cross-examination: I think you agree that the object of testing for illuminating power is to secure the opportunity to the consumer to draw from the mains of the Company 16-candle power gas—meaning by 16-candle power, 16-candle power gas as tested under the Act?

Witness: Yes. It all depends upon the main system. The Company recognize the obligation in the fullest way, and are fulfilling it—providing an excess over the 16 candles.

There is no undue burden on you?—I think the quality of 16-candle power is extravagantly high, and that it would be better if reduced; but so long as the standard is 16 candles, so long we will continue to supply it. At all points of the system where the mains were a fair size, and there was a fair passage of gas through them, such gas was supplied. It was open to the Referees to prescribe as many more testing-stations at as many more places as they thought fit and fair; and the Company were content with the obligation. The size of the mains on which the testing-places were located varied considerably. Thus, the Vinery Villas station was supplied from a 3-inch main. Witness, however, stated that if the map referred to, showing the positions of the testing-stations, had been prepared for the purposes of this inquiry, it would have given a little more information. The 3-inch main came off a 24-inch main, and was probably connected with another large main at the other end. At Graham Road, the station was supplied from a 5-inch main; but here, again, the main came off a 24-inch main, and was probably connected at the other end also with a large main. No doubt in locating these stations the Referees intended to secure a supply through leading mains.

I see that, although the gas is drawn from a somewhat small main, it is perfectly satisfactory, for it appears from the return that at Vinery Villas it is 16·2 candles and at Graham Road 16·8 candles. In other words, whether you take it from a 3-inch, a 5-inch, or a larger main, you get the same result?—Yes. If the Committee were satisfied that the method provided did not secure the carrying out of the contract between the Company and the consumers, then by all means let there be a better system.

With regard to illuminating power, with the exception of the 5 feet an hour, the burning in an argand burner, and the fact that there are to be fixed testing-places, are not the whole of the conditions of testing at these testing-places in the hands of the Gas Referees?—They are.

With that contract you are satisfied?—Yes.

The whole of the regulations necessary to secure fair conditions to the Company and consumer alike are advisedly, and with your consent, left to the discretion of the Gas Referees?—Yes.

And hitherto they have settled fair conditions for the Companies and the consumers?—Yes.

Have you any reason to doubt that, if a like discretion were given them hereafter, but with the sole variation practically of moveable as compared with fixed testing-places, they would not be able to prescribe equally fair conditions as between the Company and the consumer?—I say that, if they prescribe equal conditions of temperature, of draught, and of testing with regard to mains, we have nothing whatever to say. They are perfectly at liberty to do it.

If they do that, and apply the test of the portable photometer, the portable photometer under proper conditions would give an accurate result?—I have already stated that the portable photometer gives practically identical results. Continuing, witness said the proposal to alter the method of testing was flippant. The clause, even with the addition of words to show that the Gas Examiner should not go to "any place," which might include unfit place, but should only go to places falling within the category which the Gas Referees decided to be fair, would still be flippant. They could not possibly lay down in that room a description of the class of building, and the method of fitting, so clearly and distinctly as to make the Act suitable and proper.

Do you mean to tell me that the Gas Referees, who are competent to decide all the details under your existing contracts, are not competent to decide the conditions under this Bill?—I think it is too much to ask the Companies to make such an extended reference.

The Referees at present are able to prescribe, to the satisfaction of the Companies, conditions with regard to the existing conditions of testing.

Why are they not equally competent with regard to this proposed alteration in the matter?—I would not think of questioning the competency of the Referees. What I say is that the new method of testing suggested will take the testing away from stations where, as the result of years of experience, it has been shown that the testing can be safely carried on, and bring it to places where it may not be satisfactory—in fact, where we know it will not be satisfactory.

Did you hear Professor Vernon Harcourt, the Gas Referee, say he saw no difficulty in prescribing conditions under which fair tests could be made with the portable photometer?—I did not. I read his evidence, however, and it seemed to me that he pointed out the necessity for a considerable number of precautionary measures.

It showed that his mind was alive to the necessity for these measures?—I should say he was not consulted before the clause was drawn.

He has been consulted here. He says he sees no difficulty in applying precautionary measures?—I say that the adoption of adequate precautionary measures would simply mean the institution of similar testing-stations to those we have at present in use.

Professor Vernon Harcourt was asked if he thought it desirable to have testing-stations established anywhere in the district that might be thought desirable; and he said he did not consider it would be advisable to largely multiply such testing-stations as at present exist. Do you follow that?—I say it is not desirable to increase the expense by enlarging the number of existing testing-stations. If there are some stations which are not desirable, they could be dispensed with, and others could be established in their place in different and more advantageous positions.

Professor Vernon Harcourt said that if they could get five times as many testing-places as they had, they would go a long way towards securing what was desired; though he did not think that even that would be as effective a method of testing as going from place to place?—I was not aware of that statement. All I can say is that I differ from him as to the effect of the present system.

Then you differ from the authority you think we ought to have consulted?—I say you ought to have consulted the Gas Referees as to testing at any time and at any place.

You differ from the authority who is responsible for the testing now?—Yes.

If the Bill is to pass, you do not object to the absence of notice as to tests taking place. You object to the imputation which the words of the clause convey?—Yes; I do object.

Do you want the reference to notice in the Bill or not?—I want the words out, with the suggestion they contain, most certainly.

Then if we put on the face of the Bill that it is not intended to cast an imputation on the Gas Companies, you would be satisfied?—No; I should not.

If you had your photometer at a proper place and the tests checked by the Company, what injury would the Company suffer if a fair allowance is made for unavoidable variation?—You propose a method intricate and open to disputation and subsequent inquiry, in place of a method that is unattended by any of these troubles, and which has been proved to be absolutely reliable and satisfactory. It seems to me that what you have to do is to make out a case to show why a system which is free from intricacy should be superseded.

I agree. Where does intricacy come in?—Well, wandering about, more or less, in dark alleys to take the testings.

There, surely, are no dark alleys in the district of the County Council?—Yes there are. Then, you must have a proper room in which to conduct the test, the gas must come from a proper service-pipe, and you must know that the gas comes direct from the main and where it goes to from the main.

What is there in the Bill to prevent the Gas Referees from prescribing the room. If you do not like the Gas Examiners wandering about dark alleys, would it meet your view if they went into a pantechnicon van?—Yes; if it were a place duly appointed and properly equipped.

Re-examined by Mr. RALPH NEVILLE: You have had considerable experience in connection with testing-stations?

Witness: Yes.

Is it a fact that you do not know whether or not a testing-station is a proper one until a large number of tests have been made in it?—Yes.

If the board-school rooms are certified as proper places, I take it that you would have no objection to the process of testing which my learned friend suggests being adopted?—I cannot imagine the Gas Referees certifying those places; but if they did, we should have to accept their decision.

You think it a wholly impracticable suggestion?—I do.

As to increasing the testing-places, you say that, in your view, if there were testing-places set up at the works, they should be testing-places which would ensure that all the gas that went out from each of the manufacturing works was properly tested?—Yes.

Would you have any objection to such testing-places being set up?—Not at all.

And if they were set up, would they meet the case and provide for gas sent out of the works being of the standard quality?—I maintain that the testing-places as they exist give that security. It is impossible to have testing-places everywhere; but if they were brought down close to the works, it would be impossible to test the whole of the gas.

You do bring your gas at the works to over 16 candles?—Yes.

In order that it may be of 16-candle power 10 miles away from the Beckton works?—Yes; and to provide for the difference of observation on the part of different testers.

You think that 0·25 candle would be the illuminating power that wou'd give the personal equation for the testers?—Provision of that kind would have to be made for the personal equation.

The tests differ?—Yes.

The first test is not necessarily the same as the second?—No. The first test may take place too soon after the lighting of the candle.

The fact of the Company being deprived of notice would prevent their officials being able to look at the plans of the mains to see where the gas that was being tested was coming from?—Yes; and also prevent them from looking at the pipes leading to the premises from the main and the pipes on the premises.

The CHAIRMAN: They would be able to inspect those afterwards. But I should not think that the County Council officials would be so idiotic as to trip themselves up by making their tests at a dead-end or something of that kind.

Mr. NEVILLE: It would not be known under what conditions the test was made.

The CHAIRMAN: The officials would be very foolish if they took advantage of abnormal conditions.

Witness was understood to say that if the proposal of the Bill were adopted, and it had the effect of causing the Gas Companies to raise the present illuminating power of the gas, he should regard it as a serious breach of the contract entered into between the public and the Companies, when the standard quality and price of the gas were fixed. If the 16-candle gas now supplied was rendered 14 or 15 candle gas by the adoption of a new method of testing, the Companies would have to raise it up to 18-candle gas from the point of view of the present method of testing. This would impose enormous obligations on the Companies.

Mr. LEIGHTON: One of your objections to taking the portable photometer to any house, is that the service-pipes or connections may not be in good order; and that, therefore, the gas supplied in the house may be of a lower quality to that in the main?

Witness: What would happen would be this: You might take the photometer into a board-school room, and you might there get gas for the purpose of testing which had been lying in the service-pipes for weeks.

That would be obviated by blowing out the gas?—That would not be an easy matter. You would have to take off the meter, too.

Supposing the difficulty as to the service-pipe was got over?—Then there would remain the difficulty as to the room.

I understand that, in your view, many of the service-pipes are not in good order?—That is so.

And they are not under your control?—They are not. We supply the service-pipes; but I refer to the pipes that are on the property of the consumer. In every house there are certain pipes through which the gas flows after it leaves our mains, and over which pipes we have no control.

Would your objection fall to the ground with regard to testing with the portable photometer if the testing took place where the prepayment system is adopted, and where the pipes are under your own control?—No; because there would still be service-pipes through which the gas would pass. Those pipes might be dirty and full of deposit.

You cannot put forward as an objection to the consumer having 16-candle gas that the service-pipes you yourselves provide are out of order?—If one case of a defective service-pipe occurs in a thousand, there is nothing for the Company to be ashamed of.

I say your objection would fall to the ground if the test were made on premises to which you yourselves supply the fittings?—If the premises were connected with a live main.

But it is your business to provide proper fittings?—The pipes may have been in use twenty years.

Then, why not replace them? You take payment for them?—We take payment for the gas carried through them.

But the fittings are yours?—If complaint is made that they are out of order, they are put right. To a certain extent, I am with you that where we do put in the pipes they ought to be in such a condition that the gas for testing could be taken from them.

Mr. NICOL: You admit your obligation as regards the supply of 16-candle gas, not only in reference to the main, but also in reference to the service and other pipes outside and inside the house, when connected with fittings that you put in?

Witness: No; we say that the mains we use should be suitable for connecting with the portable photometer.

I understand you to say that you are responsible for the supply to the consumer of 16-candle gas where you own the fittings?—No. The photometer would be connected, not with the fittings, but with the pipe that comes from the main. That pipe, in 99 cases out of 100, would be in good order.

Mr. LEIGHTON: You do not consider that an obligation rests on you to provide to the private consumers 16-candle gas?

Witness: Our object is to supply in the testing-places directly from the mains 16-candle gas; but there are many causes which make the gas, as used in the houses, of less than 16-candle power.

Mr. NICOL: The machinery that brings the gas to the house may in many cases be faulty?

Witness: Yes.

Mr. LEIGHTON: But you do not consider, as a Company, you are under obligation to supply to houses throughout the district 16-candle gas?

Witness: No; that would be going too far. But we do undertake to supply gas of 16-candle power in the mains.

If the connections are as they should be, the gas in the main would be the same as it is in the house?—There would be a very slight difference.

Mr. LEIGHTON: Then, we come round to the same point. If the gas in the street is of 16-candle power, and the fittings are as they ought to be, the gas in the houses will be very little below 16-candle power.

The CHAIRMAN: Summing up your evidence, am I right in coming to the conclusion that you, as an expert, and as a Director of the Gaslight and Coke Company, have no objection whatever to any increase in the number of testing-stations that the Gas Referees may prescribe?

Witness: Our only objection would be as to cost.

You said the cost of a station would be about £200 a year?—Not including the salary of the tester, which is paid by the London County Council.

Can you not estimate it at less?—No.

You have no objection to the increase of the testing-stations?—No.

The CHAIRMAN: And so far as the peripatetic photometer is concerned, *quâ* photometer, you have no objection to that?

Mr. POPE: As an instrument.

Witness: I have not.

The CHAIRMAN: The use of that photometer for the purpose of testing the gas would meet with your approval, if the conditions under which the instrument was used were satisfactory?

Witness: Yes.

But having regard to the expressions in clause 3 of the Bill, enabling the Gas Examiners to make inspections at any place, you think the Company would not have a satisfactory guarantee of the conditions of the use of the peripatetic photometer?—Yes.

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See also Advt. p. 1180.]

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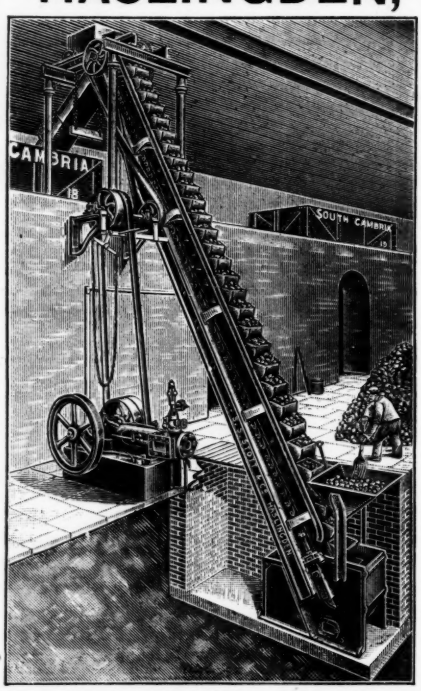

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Therefore, your objection is not to the photometer itself, nor is it owing to doubt in your own mind that the gas supplied by your Company in the mains is unsatisfactory and below the standard, but your objection is because you have no reliance on the conditions of use of the peripatetic photometer?—Yes.

And you think that, whereas the use of this peripatetic photometer would be a sufficient reason for notification to you so that you might use means to remedy any defect, it would not be sufficiently safe to constitute a basis for the imposition of a penalty?—Having in view the use of an efficient machine to make the test, that is my view.

Mr. *Greville Williams*, examined by Mr. POPE.

Witness said he was one of the Chemists of the Gaslight and Coke Company. The determination of the illuminating power of gas required great care. With the existing photometer, it was necessary that the conditions of the use of it should be carefully settled, in order to obtain a proper result.

Mr. POPE: What do you say to the use of the portable photometer. In your judgment, is it possible to secure such conditions as would bring about accuracy, whatever the instrument might be?

Witness: The portable photometer, properly used, is a scientific and accurate instrument.

Would you say that, to obtain conditions such as to secure accuracy, would be difficult?—I do not say that it would be difficult; but it would necessitate the taking of many minute precautions.

What conditions?—There must be no draughts. If there are, you get irregular results. The 16-candle argand burner is liable to be affected by draughts. I cannot estimate the amount of influence that draughts have; but I know that they produce irregular results.

You cannot say how much, scientifically, should be allowed in respect of that?—No. There are photometer users who altogether ignore the question of draughts.

What is the next cause of error?—Another one, and the most serious of all, is the atmosphere of the room. On every occasion when the photometer has been in a very cold room, the results have been low.

I should like an illustration of that?—I took as an experiment the meter of a photometer, and cooled it moderately with ice. I did not make it very cold, but produced in it the temperature you would have on a cold day—that is to say, I reduced the heat to 11° Fahr. The illuminating power of the gas at once went down ¼ candle. I reduced the power altogether ¾ candle. The evils to be guarded against in using the photometer are cumulative.

What is the third condition affecting the accuracy of results?—There is the personal equation of the operator. There are some men who instinctively read a little high, and some who read a little low.

And some who read what they want to read. I usually notice in scientific observation that the observer finds what he wants to find?—I do not say that. I say we very often try to find something, and do not succeed.

That is in honest observation, of course. What is the next condition of error?—I do not know that there is anything else. The cold is the main thing. It not only affects the photometer, but the gas itself. Gas, when cold, loses some of its illuminants. If you pass coal gas through pipes in ice, there is a condensation of the benzene and ethylene.

Can you fix any allowance representing the permanent risk of inaccuracy in the proposed mode of effecting the test?—No.

Without that, it would be an unfair mode of testing to apply a penalty to?—Certainly. If you take the portable photometer into a cold room, you do a very serious injustice to the gas. A question had been raised as to whether a wet meter was more injurious to gas than a dry one. The two acted in different ways; but even a dry meter was injurious to the gas. The result of his investigations and experiments showed that, in order to make a test satisfactory and accurate, it ought to be in a fixed and properly prepared station. If he took any photometer into a different place, under different conditions, he would get different results.

You cannot get an accurate result without providing against all these dangers that you refer to?—Most decidedly not.

Mr. NICOL: To do that, you must practically use a fixed or stationary photometer?

Witness: Yes.

Mr. TALBOT (in cross-examination): With the old photometer, there was no need for a particular room?

Witness: Well, as a matter of fact we were very careful even with the old photometer; but they were much more protected, because they were in cases.

Were they satisfactory instruments?—I and other men of great experience say "Yes, if you used them properly."

Of course, there would be nothing under the Bill to prevent the Referees prescribing a test with that class of instrument?—I do not think there is the slightest chance of the Referees ever going back to the old system of candles. I think the present table photometer is a distinct advance. It is a scientific instrument. Gas, to be properly tested, should never fall below 65°. The Gas Referees could prescribe the temperature, though he believed they did not do so. Mr. Vernon Harcourt, in expressing approval of the portable photometer, had not had the disastrous experience of it which witness had.

Mr. *W. C. Young*, examined by Mr. POPE.

Witness said he was Gas Examiner to the Corporation of the City of London, to West Ham, and to many other corporations and companies. For the purposes of the Bill, he had made a series of experiments, one set being at No. 37, Lordship Park—one of the houses referred to by the London County Council—on April 18 last. The tests were made with two absolutely identical photometers, placed side by side on the ground floor to prevent draughts; only five persons, all experienced in the use of the instrument, being in the room. The temperature varied from 65° to 71° Fahr. With one photometer, the tests varied more than a candle, and with the other by about half-a-candle. The difference in the tests under his personal observation was 1·1 candles with one instrument, and 0·6 candle with the other. The difference between the means of all the tests taken with one instrument, compared with the mean of all the tests taken with the other, was 0·11 candle. Thus the results brought out that the two photometers were pretty well identical.

Mr. POPE: You made an experiment at Central Street, St. Luke's, with the same instruments, and employed the same means of testing; taking all precautions to see that the photometers were accurately set up and that the proper conditions were observed?

Witness: Yes; taking care to limit errors as far as we possibly could.

Does the result show accuracy or inaccuracy?—The first showed very great inaccuracy. One photometer gave lower results than the other. One photometer gave 15·67 candles; the other 17·71 candles—a difference of 2 candles. The test was carried out with the same instruments as those used at Lordship Park. The different tests were made with an interval of five minutes.

Mr. NEVILLE: Can you account for the difference?

Witness: No; I cannot. So far as I could observe, the tests were made under identical conditions.

Mr. POPE: What conclusion do you draw?

Witness: That the instrument is altogether unsuitable for hurried testing.

That hurried testing does not enable you to get conditions that ensure accuracy?—That is so.

Mr. NICOL: You made these experiments without notice?

Mr. POPE: They were made by us.

Mr. NICOL: Quite so, but the Company's officials did not know at what time and at what place the experiments were to take place?

Mr. POPE: Not so as to manipulate the gas.

Witness: The tests were made for the Gas Company.

The CHAIRMAN: Was the condition of the two machines identical?

Witness: Yes.

Each adjusted in the interest of truth?—Yes.

And you were there to ascertain the real illuminating power of the gas?—Yes.

And a difference, practically, of 2 candles is the result of your inquiry?—Yes.

Do you suppose that the difference of 2-candle power would have been caused by some change in the quality of the gas in five minutes?—No.

To what do you attribute it?—It must have been attributable to a defect of some kind that I could not observe—some defect in the argand burner, or in the standard flame with which the gas was compared.

Was it in a closed room?—Yes.

And the conditions as to draught were identical?—Yes.

And the conditions of temperature?—Yes.

And these being the chief sources of deviation, according to the last witness, I suppose the balance of inequality arises from the personal equation?—Yes.

And you say that in this case it was unbiassed?—Yes.

Therefore, as an expert, you cannot tell us what the cause of this thing was?—No; I tried to find out, but could not.

If you had been at an official testing-station, and you had had these two photometers at different tables, the same difference would have occurred?—I cannot say. One was at the corner of the room, and the other was at the door; and whether or not there was a current of air which reached the one or the other, I cannot say.

The CHAIRMAN: There might have been some strange disposition in the mind of the photometer—the one in the corner was perhaps not quite so cheery as the other.

By Mr. NEVILLE: In all the experiments made by these gentlemen—Mr. Ford and Mr. Taplay—the difference was the same. Of the 2-candle difference, ½ candle was explained by the position of the photometer in the room, and the other 1½ candles was due to something in the instrument. There was another series of experiments in which the photometers were changed. Generally speaking, he should say, as to the suitability of any school-board room or anywhere else for taking tests, that such places were most unsuitable without previous trial. Trial and experiment was necessary to find if a room was a suitable place for testing gas. This was always done in the case of a fixed testing-station, before the place was decided upon and approved by the Gas Referees.

Mr. NEVILLE: You have known of a case where the premises on trial were found to be unsuitable?

Witness: Yes.

And something was done to make the place suitable?—Yes. I have also known a place regarded as suitable given up after a long series of experiments and investigations had taken place.

Witness went on to say that he was present when the tests spoken to by Dr. Clowes took place at Compton Street. They were conducted in the same way as the tests of which he had been speaking. They took place during three days; and he had been present during the first and last day. As to the results of the tests, the photometers were placed side by side in the room, and the results were practically identical—showing that the instruments could be relied on, under suitable conditions, to give equal results. Then one of the photometers was taken away to another room. In one case, the flame of the burner was so unsteady that the reading of it was only approximate. One was shifted to a place between the door and the open window, and the other was in a through draught; but there was very little difference between the results.

Do you think these photometers can be relied on to give accurate results?—I do not.

On the third day, the tests were fairly in accord?—Yes.

Do you consider, from the experiments, that these photometers can be relied on?—You get different results, according to the room in which you place the photometer. The instruments were adjusted as I myself should have adjusted them to obtain as accurate a test as possible. He had seen the series of experiments published by the London County Council, showing an illuminating power of less than 16 candles. They were made with the old form of photometer. The candles should be burning at least 15 minutes before the taking of a test. A test taken after the expiration of 10 minutes, generally gave a much lower result than one taken after the expiration of 20 or 25 minutes, and the latter would be lower than a third taken after the expiration of 30 minutes. Half-an-hour or 40 minutes after the candles were lighted, they gave practically uniform results. Then photometric results of tests taken by candles depended largely on the length of time the candles were burning before the tests were made. This was so true that, in testing where the first result was low, he invariably went on and took three tests, and then assumed that the average was the quality of the gas. A fourth series of tests was made at Clerkenwell; and they showed that the two photometers were more discordant than ever before.

Mr. WILKINSON (in cross-examination): You consider that the portable photometers as instruments are satisfactory?

Witness: Undoubtedly.

The fault you find is that the rooms in which you tested them yourself were all unsuitable?—Yes.

They were not a class of room which you, as an experienced man, would choose to test with a portable photometer?—I should not decide that until I had made a number of tests.

But you will agree with me that the Gas Referees, who are experienced men in these matters, would not be likely to choose a room to make tests of the portable photometer which was unsuitable for the use of the apparatus?—Our experience of the Gas Referees goes to show that they are open to conviction in the matter of the selection of the rooms.

Mr. NICOL: If the Referees have to increase the number of testing-stations, whatever instrument is used, the place will have to be specially prepared, and experiments made to see if it is suitable for use with this or any other photometer, so as to get an accurate result?—Yes.

By Mr. LEIGHTON: He was employed to test in a number of towns in the provinces, and took his own apparatus. He had never used the portable photometer unless it had been fixed and the gas passing through for at least 24 hours.

The CHAIRMAN: How would you arrive at the conclusion in your own mind as to whether a place is fit or not?

Witness: I should judge by the temperature and the absence of draughts, as far as I could.

Are not those conditions ascertainable before you proceed with your experiments?—No; I am afraid not. One might decide that a place is perfectly suitable, and find out afterwards that it was not.

You would declare its suitableness or unsuitableness by ascertaining whether it indicated that the Gaslight and Coke Company's gas was 16 candles?—Yes; or was the quality they expected to find at that spot.

It is rather a peculiar index?—But as a matter of practice, it is the fact that the results come out below the requirements. That raises a suspicion as to the suitability of the place.

According to your answer, you come into the room with the certainty that the gas in the main is 16-candle gas. You come in in an informal sort of way to make an investigation. You say this is air-tight, and is at the proper temperature; there is sufficient oxygen in the atmosphere; and I will proceed to light my apparatus, and make a test. If the test agrees with the 16 candles, the place is a good one?—Yes.

If it does not, the place is a bad one?—No; the place may be a bad one.

Do you proceed to condemn it forthwith, because your stupid photometer does not indicate 16 candles?—Well, in that case we would have previously ascertained that the gas near the spot, and at some other place, gave a higher result. Witness went on to refer to instances in which low readings at a station were checked by other tests taken close to the station, but for which the Company would have been penalized.

Professor *Vivian B. Lewes*, examined by Mr. DANCKWERTS.

Witness said he was Chief Superintending Gas Examiner to the Corporation of the City of London. He attended to give evidence on a Speaker's warrant; being subpœnaed on behalf of the Gas Company. He had officially tested the gas supplied in the City by the Gaslight and Coke Company since 1879.

Mr. DANCKWERTS: In the City of London, has any such thing come under your notice as there being a variation in gas at the time the test was expected?

Witness: None whatever.

I think in the City of London the Company never attend the testing?—I believe it has only occurred once in the last ten years. Nor had they ever asked for notice to be given of the time the tests were going to be made. It was in the City of London, in 1892 and 1893, that the two instances occurred when the gas was below the standard. The cause was entirely an accident. The Company were then introducing carburetted water gas for enrichment; and they did not quite get the working of the generator, which they overheated, in the absence of the Manager, and really burnt up all the oil. The gas was tested in the City at all times, whenever was thought fit. Besides the testing-stations in the City, he had a room fitted up in exactly the same way as the testing-stations, and there he made tests which, although not official, were on all-fours with those at the stations.

Do they confirm the tests at the stations?—Not altogether. They are slightly lower.

Why is that?—Because they are some little distance from the mains. I have had two of these places, which gave me an opportunity of judging really what the loss of power in normal distribution may be taken to be. During 1892-5, I had an office in Guildhall Chambers, at the bottom of the yard leading out of Basinghall Street. This was at the extreme end of the Bow Common main, which will represent the worst conditions of distribution in which you will get gas in the City. The mean average illuminating power of the gas, taken day by day, and year by year, there was 15·6 candles. At the gas-testing station during that period, the illuminating power was 16·6 candles—1 candle higher. At the present time, the office is removed to Whitecross Street; and there we are nearer the main than was the case with the other building. My average tests are 16 candles there; while at the testing-station the average remains about 16·6 candles.

What is the difference due to?—To the difference in the rate of flow of gas. All the time that you have gas flowing through big mains, there is no deterioration. When you get down to the smaller mains, as long as the gas is continuing at a fair rate of flow there is still only a very small diminution in the illuminating power. But directly you go from the distributing mains to the cross-services, in which the rate of flow becomes extremely slow, you begin to get a diminution; and it is under these conditions that you go down from 16·6 to 16 candles. Where you have anything approaching a dead-end or stagnation in the flow of the gas, you reach your lowest results; and it was at an end of that kind that I had my office in Guildhall Chambers. That is a matter which the Company cannot control.

With respect to the variation found by the use of the portable photometer, have you formed any conclusion?—The portable photometer, as at present suggested, is a very excellent form of photometer. It is identical with the form of photometer which we are having at present fitted in the chief testing-stations. There is not a word to be said against it as an instrument; but I do consider it would be extremely dangerous, without a very long series of carefully considered experiments made by experts, to suggest that the photometer might be accepted under any conditions. My own opinion is that the requirements, to obtain good results from it, are so delicate that you would have to come back to certified stations.

Would you think that, carried about from place to place, and fixed in any house (say, a school-board), it would give good results?—I should view results obtained in that way with very grave suspicion.

The gas which you get in the City comes mainly from Beckton?—From Beckton and Bow Common.

Do you think it would be possible to manipulate the gas so as to alter the reading of the instruments?—I do not. My reason for saying so is that if you take, for example, the gas of Beckton, you have it flowing in from Beckton in 48-inch mains, a distance of something like 8 miles. These mains will contain half-a-million cubic feet of gas, which means many hours' consumption; and any alteration of the illuminating power will take hours before it is felt at the testing-stations.

Mr. POPE: If it were tested at the works, you could always tell what went into the mains?

Witness: If it were tested at the works, there would have been none of this trouble arising at all.

Further examined by Mr. DANCKWERTS: At one time, he had a testing-station at Jewry Street; but it was moved, because there was considerable variation in the illuminating power of the gas. Early in the morning, or after standing some time, low tests were obtained; and then after awhile the power would go up. Though this was a common phenomenon, it took place to an excessive degree. He and the Company made a very careful examination; but no explanation could be found, and the result was that the station was moved to Fenchurch Street. After the removal, the main which fed this station was taken up, and found to be thickly lined with the crystalline hydrocarbon, naphthalene—matter of such a kind that if the gas had stood in it undoubtedly a great deal of the illuminating power would have been abstracted. In the City, gas was largely used for heating, and also for motor purposes in the crowded neighbourhood round Fleet Street, where there was no room for steam power. For this kind of use, illuminating power was not so important. The reason it was impossible to get a uniform supply over a large area was that the illuminating power of gas varied with the length of time it was in a pipe—the rate of flow. If gas stood in the cross pipes from night till the next day, there would be a very serious diminution in power. Board-schools were often placed in back streets, and would therefore be peculiarly liable to be supplied from dead-ends where there would not be probably a constant flow in the main.

Mr. DANCKWERTS: Does the system of fixed stations for testing purposes, with power to the Referees to prescribe further stations, amply secure the consumer?

Witness: I should say it secures the consumer as far as the consumer can be practically secured.

Supposing a testing-station were fixed at every works, so that all the gas issuing from each works could be tested, would that afford security?—It would afford far greater security than the present method of having the stations in the area supplied. This was fully pointed out in the evidence which was heard at the time the stations were fixed in the area. At that time, Dr. Pole, who was an ideal Gas Referee, gave evidence on the case; and he pointed out that you would have far greater protection by having the testing-stations at the works, or within a short distance of the works, than in the area, because you would do away with all chance of the Gas Companies sending out other mains over a district not tested.

[An extract from the evidence of Dr. Pole given on June 28, 1875, bearing on the point, was handed in by Counsel.]

If it be correct to say that in passing long distances in big mains gas does not lose illuminating power, by testing-stations at the works the consumer would be protected?—Yes.

Have you formed any opinion about the desirability of this Bill?—It is a Bill which I look upon with considerable doubt. I think it is a Bill which will not be very much in the consumer's favour.

Can you explain why you come to this conclusion?—If the Bill was to be passed into law, it would render absolutely necessary the enriching of the gas by at least, I should think, 3 candles, in order that in such cross mains as you have the gas standing in it should hold up sufficiently its illuminating value to give 16 candles when tested by the portable photometer. In order to get this 3 candles of enrichment, the Gas Companies would have to expend at least 3d. per 1000 cubic feet on the gas, and the chief part of this would undoubtedly fall on the consumer. Presuming they put up the price of gas 3d., this, on the price charged in the City by the Gaslight and Coke Company, would be an advance of 8½ per cent., and on the South Metropolitan price it would mean an advance of 12 per cent. The advantages which the consumer would get would not be at all commensurate. If the whole of the consumers of London had 15-candle gas, and it were then increased by the passing of this Act to 16 candles, the benefit they would obtain would not be equivalent to the percentage added to the cost. I base my opinion on this point on the following facts: If you take the general consumption of gas over the whole area of London, you may take it that 50 per cent. of the gas is burnt for fuel and motor purposes, 15 per cent. more is burnt in incandescent lighting, and the remaining 35 per cent. is consumed in flat-flame and other forms of burners. Now, with an incandescent mantle the difference between 16 and 15 candle gas is 3·1 per cent. That is to say, you get 3·1 per cent. less light with 15 than with 16 candle gas—that is, if you carefully regulate the air supply and so forth. When you come to gas-fires, you find a 3·1 per cent. calorific difference between 15 and 16 candle gas. Passing to flat-flame burners, it is there that you find the greatest loss. These flat-flames are not fitted for the low quality of gas; and the difference between 15 and 16 candle gas is over 15 per cent. Taking all these percentages together, you find that they amount to 7·6. That would be a loss, as against which you would have to pay 8·6 per cent.; so that there would be a final loss on the whole transaction of 1 per cent.

That assumes that the peripatetic photometer would secure the results you have mentioned?—Yes.

Mr. WILKINSON (in cross-examination): To what cause do you attribute the loss of 0·6 candle in your testing?

Witness: To the gas lying in stagnant cross-distributing pipes.

The class of place is to be prescribed by the Referees?—The right way to prescribe them would be to say that they should be on a flowing main.

You have found two suitable rooms in the city at which you have conducted proper tests?—The rooms are not satisfactorily situated, as they are not on a flowing main.

But the conditions are satisfactory?—Oh, yes.

Mr. LEIGHTON: If the fittings in the houses are in proper order, ought not the gas to have the same illuminating power as that in the main?

Witness: Yes.

The contract of the Company with the public is to supply gas of a certain value within a certain area?—Yes.

What is the gas value?—16 candles.

You say that the Bill, if passed, would require an addition of 3 candles to be made to that 16 candles?—Yes; to make sure that the gas on the cross-mains was 16-candle gas, you would have to raise the power by at least 3 candles.

You admit, then, that the gas now supplied, when it reaches the houses of the consumers, is under 16 candles?—In the city we divided the consumers into three classes—viz., those who receive gas of ½ candle over 16 candles, those who receive gas of the right quality, and the class who receive gas ½ candle below 16 candles.

So far, then, the Companies have failed in their contract to supply 16-candle gas?—No. Their contract is to supply it in the area, and that they have done.

But in a portion of the area they fail to supply 16-candle gas?—It comes to that.

Mr. DANCKWERTS: Is it humanly possible to supply gas of one quality throughout the mains.

Witness: If the Company send out 20-candle gas, I will guarantee to still find places where it does not reach 16-candle power.

By Mr. EMMOTT: He had not made any experiments *ad hoc* beyond the two described.

By the CHAIRMAN: He did not think the proposals of the Bill, if it were carried, would be serviceable. The operation of gas-testing, in his opinion, was so delicate a one that it required more elaborate preparation of the place for carrying the work on than was contemplated in the measure. As a scientific expert, speaking in the interest of correctness and truth, he thought that accurate tests could not be secured by the adoption of a system of testing at any point which might meet with the approval of the Referees.

The CHAIRMAN: Would not the approval of the Referees be a protection to the Company?

Witness: If they examined the places of inspection, and gave certificates for them, it would be a protection; but this would mean the present system. I do not believe that the Referees would approve of tests taken in the cross or "gridiron" mains. If tests were made promiscuously, the Company would not know where the gas came from. In many instances, it would only be the gas-distributing engineers who would know.

Thursday, May 3.

Professor *Dewar*, examined by Mr. POPE.

Witness said he had acquainted himself with the system hitherto adopted for determining the illuminating power of gas in the Metropolis, and the suggestions that were made in connection with this inquiry.

Mr. POPE: In your judgment, is it possible to have a satisfactory test of illuminating power by means of a portable photometer taken from place to place?

Witness: No; not as compared with the present mode of testing the illuminating power at a central station. It is well known, scientifically, that the photometric method of testing in itself is a very delicate one. Most careful precautions must be taken; and I think I could not do better than read a passage from a most quoted and recent book on photometric measurement. It is a treatise on "Industrial Photometry," by A. Palaz, who is a Professor at Lausanne University; and in Chapter IV., on "General Equipment and Auxiliary Apparatus of Practical Photometry," he says:—

> The preceding chapters have been devoted to the study of photometric apparatus and units of measurement. There remains to be found the best manner of arranging them for measurements, and the precautions which must be taken to obtain satisfactory precision. In every laboratory where it is desired to make photometric measurements, there should be set apart a special place judiciously chosen, and satisfying the following fundamental conditions. The photometry-room should be large enough. It is a great error to crowd the photometric apparatus into a small room, especially when photometric standards based on combustion are used—*e.g.*, carcel, Hefner, petroleum lamps, candles, &c. The luminous intensity of these photometric standards varies greatly with the degree of purity of the surrounding air; it diminishes in proportion as the quantity of carbonic acid gas in the air increases. For instance, at the end of an hour the products of respiration of two people are sufficient to vitiate the air in a large room so as to produce a very noticeable diminution in the luminous intensity. Further, the presence of lights brings about an elevation of temperature which contribute to render the measurements less exact, owing to the fatigue of the observer. This can be remedied only imperfectly in a photometer-room of small dimensions, by introducing a little stronger system of ventilation. No attempt should be made to use ventilating apparatus during the measurements themselves, for the photometric standards should be free from even the smallest currents of air. Recourse should be had to it between measurements, which, however, produces each time a disturbance in the regulation of the standard lamp. We do not know then whether the luminous intensity of the lamp returns to its initial value or not. The photometry-room should have its walls painted a dull black; and it should be possible to obtain complete darkness. This condition is indispensable if the photometric-screen is to receive only such light as comes from the two sources to be compared. It, moreover, permits the eye to rest in the interval between the measurements. The light necessary for reading the apparatus and making notes should be furnished by lamps of small intensity fitted with reflectors which do not allow the light to be diffused over the room.

That, I say, sums up the exact position of modern science in regard to photometric measurements.

Speaking now, not as a scientific man, but as one of the public, that seems to me to show it is very difficult to secure perfect conditions with photometric exactitude?—That is true.

Therefore the most that you can do, as a practical question, is to approach as nearly as possible to the conditions which have been laid down?—Yes.

Assume, for instance, that either the Referees or Examiners, or anybody else, were, for the purpose of fixing the penalty by the attaining of an average, to avail themselves of an opportunity to use photometric apparatus, I may call it haphazard, at a board-school, a dwelling-house, or a large theatre, would the conditions be such as to deprive those results of all practical value?—I say they would. I say there is no possibility, in my judgment, after hearing the evidence that has been given, to account for any such deterioration as 2 candles difference, or even 2 candles difference between the central stations, on the ground of the mere difference in the photometer—the mere instrument itself. It must be the conditions of use, and in the sampling of the material being tested.

I gather that, in many of the cases in which results have been given to us, the gas has been taken, not from the mains where it was lively, but from the burner in the room where the test is about to be made—no doubt with a view to ascertain the quality at the burner itself?—Yes.

Are those conditions such as may be fairly comparable?—I say there is no possibility, in my judgment, of making the tests taken as a standard at the central stations comparable with a test taken, for instance, at a board-school, as has been described, or any public building. In the case of the testing-station, there is always a moving current of gas taken direct, as nearly as possible, from the large supply in the main. You go into a building of the kind mentioned (say) with 200 lights, with small pipes, and the gas has not been used for some hours. There are 200 lights; and a diffusion of air is taking place by the lighting of this gas. This is entirely different from anything that will occur at the central station. The consequence is that you will require to burn the gas, in order to get a sample comparable with what you take at the central station. Then probably you will not get it.

Do you think, therefore, that the result (though not by any means scientifically perfect) obtained by the present system of testing in central stations, is better than it could possibly be by the use of the portable photometer?—I have no hesitation in saying, "Yes, undoubtedly."

When you are dealing with questions of imposing a penalty for the non-performance of an obligation, as a matter of course you must have an accurate test, or you would be in danger of committing injustice?—Yes; if you mean that the accurate test is to be still judged by the values obtained at the central station. But by the evidence, I thought it had been admitted that, while at the present time a penal position was thrown upon the Company by a variation of 3 per cent., it was suggested that 6 or 9 per cent. might be judiciously given if you had a peripatetic photometric system as proposed.

Have you any means of ascertaining whether that would be a fair allowance to secure accuracy?—No one could do that, except after an exhaustive inquiry and a large number of experiments.

It is possible to make allowance in scientific experiments for causes of inaccuracy; but you must ascertain beforehand what proportions mean inaccuracy?—Yes. You may say with certainty that it is an absolutely different mode of sampling the gas to go into a large building, where the gas is not in active use, and take it from the small pipes at a place where there are 200 lights, and to test the gas at a central station. If you took the gas from the other side of the meter, you would have the nearest approach to the sampling of the gas at a fixed station.

If you introduce the conditions you require at a board-school testing-place, you would transform that room into a fixed station?—Yes; to some extent.

Witness went on to say that it was one thing to use a portable photometer as a means of inquiry only, and, from the results, to give a moral warning to the Gas Company as to deterioration or any peculiarity in the gas in a district—in fact, to co-operate with the Company in remedying an evil—but the suggestion in the Bill was quite another thing. The present method of testing was the best practicable security to the consumer that could be devised.

Cross-examined by Mr. WILKINSON: The quarrel you have with the tests as proposed in the Bill is that you do not consider that the conditions under which they will be taken will be satisfactory?

Witness: That is so.

You are familiar with the notifications which the Gas Referees make in prescribing the conditions under which the tests shall be made at the fixed stations?—Yes.

In one part of the interesting extract you read, it was said that, to make a satisfactory test, the walls of the testing-place should be black?—I say that now.

You know that, in the requirements of the Gas Referees, there is nothing as to a black wall?—I am aware of that. I have given the results of recent scientific investigation. All the photometer rooms of the Welsbach Company have blackened walls. Of course, screens are a sort of equivalent for blackened walls.

You would, speaking generally, accept the conditions that the Gas Referees would prescribe?—I might not like the conditions they laid down, or might not consider them very scientific; but the Companies would have to accept them. The Referees might prefer screens; whereas I should prefer blackening the walls. They would be adopting the same principle as myself, only using it in a different way.

Do you think that the conditions in which a test is made in a board-school could be so settled as to render such a place a fit one for making a test?—Yes. You could blacken the rooms, no doubt; and if you were to select proper rooms and heat them, you could control the temperature.

The conditions being satisfactory, you would agree to the fairness of the test?—If the conditions were satisfactory as to the mere photometer, the results, I should say, would be correct.

Speaking generally, you would not dispute the capacity of the Referees to prescribe the conditions?—Certainly not.

The CHAIRMAN: The witness speaks of absolute accuracy as a scientist; whereas the Referees merely desire to obtain practical accuracy.

Mr. WILKINSON: That is so.

Mr. POPE: Yes; that is so. (To witness:) You could not, with the portable photometer, secure accurate tests?

Witness: The tests could never be as accurate as those at a fixed, specially fitted laboratory.

Mr. LEIGHTON: One of the objections to testing the gas in varying places, is that the gas in the main is different to that in the consumer's house?—Yes.

How long would it take to exhaust the gas in a house?—It is not possible to say, especially in the case of a board-school.

Do you believe that the gas distributed over the district is of the same illuminating power as that found at the fixed testing-station?—Yes; unless there is some want of active circulation.

So far as the Company are concerned, if the test were correct they would not be injured?—No; if you take a sound method of testing the gas. You must then arrive at a fair allowance to make of difference between the results at the varying testing-places and those at the fixed stations, before exacting a penalty. No one can say whether it should be 3, 6, 9, or even 15 per cent. At present, there are no means of fixing the allowance in connection with the portable photometer.

If, by some new process, you could show the true value of the gas, the Company would not be penalized?—That depends upon whether you are going to take up the position that gas is to be supplied of 16-candle power at any time or any place, whatever the ramifications of the gas may be—whether you are to take it from outside the house, or with from 2 to 5 per cent. of air in it.

Then the gas is not the same all over the district as it is at the fixed stations?—No; owing to diffusion of air and to deterioration through stagnation.

May I take it that the gas is not the same in the district as in the mains?—It is the same in the chief mains, but not in the subsidiary ones.

If the new processes of testing are just and fair, the result would be the same—you would find 16-candle gas?—Yes; if you made the portable photometric tests comparable to the tests made at the fixed stations, you would get the same results.

You do not object to the new tests in themselves, but as to the justice and fairness of their conditions?—I deal with two propositions, the change in the conditions of using the photometer and the change in the conditions as to the mode of supplying the gas. I compare the new conditions with the old ones. Which is to be the proper standard?

Mr. Leighton: You are bound to supply 16-candle gas.

Mr. Pope: The definition of 16-candle gas is 16 candles as ascertained under the provisions of the statute.

Mr. Leighton: That is the method of testing the gas. There is nothing about the testing-station there——

Mr. Pope: I think there is.

Mr. Leighton: I had not finished. There is nothing about that in the section that gives authority to provide 16-candle gas?

Mr. Pope: Yes; there is.

Mr. Leighton: No; it comes afterwards.

Mr. Wilkinson: There is nothing about testing in the section that creates the obligation to give gas of a certain number of candles.

Witness said it had struck him, from the evidence, that the impression was conveyed that the gas was 16 candles all over the district. He was not surprised at there being a diminution of ½ candle in some places; but this did not show him that there was not 16-candle gas in the mains.

The Chairman: If the portable photometer showed 18-candle gas, would that convince you that the gas was above 16 candles?—Oh! yes.

Witness (continuing) said the conditions of deposition were so complicated and uncertain, that no one could tell why the deposits were made, or why they should occur more in one place than another. One could not predict where they would occur.

Mr. Emmott: Did I understand you rightly that you considered the limits of error in observing the photometer tests were as much as 1 candle out of 16?

Witness: No; I never suggested such a thing. I only said 1 per cent. They are suggesting that we ought to have 6 or 9 per cent. I say: Who is to determine whether we ought not to have 12 or 15 per cent. by this mode of testing?

The Chairman: I gather, from your evidence as a strict scientist, that you consider the selection *ad captandum* of places for inspecting gas would, in practice, be misleading?

Witness: Deliberately I say so—misleading in the sense of the results.

And it would be misleading on the ground that the conditions at the spots so chosen would be practically uncertain?—That is so.

And that the conditions are so subject to modification by a variety of circumstances, that you could not, as an exact scientist, take for granted that the results were truly indicative of the condition of the gas as an illuminant?—That is so.

You lay considerable stress upon this—that such a loose method of selection of a site for investigation would be misleading, on the ground that there could not be any reliance on the fact that the gas taken from the main was truly representative of that supplied by the Companies?—That is so.

As regards the photometer itself, as an instrument, you would have quite as much confidence in it as in the table photometer now adopted in the stations?—Yes.

But with the conditions surrounding the photometer at the moment of use for this purpose, it would be, from a scientific point of view, unreliable?—Yes.

More unreliable because of the conditions being more variable?—The conditions being varied from what they are at a district testing-station.

May I ask you to divest your mind now of the scientific aspect, and turn to the practical aspect—as a practical matter in which we do not deal with decimals of four points? As a practical issue, having regard to the London consumer of gas, do you still think that the conditions applying to the question as to whether we get a fair sample of the gas supplied would still be unsatisfactory as a commercial test?—Do you mean if the Bill were passed?

If the Bill were passed?—It would be unfair.

I will not say if the Bill were passed, but if the selection of places were made in the broad *ad captandum* style suggested?—I say it would be unfair, because unreliable on the two points of the difference in the conditions of use and the difference in the conditions of sampling.

You think your position as a witness to-day is confirmed by the action in Liverpool, which has resulted from experience in settling down to six chosen places instead of the miscellaneous choice that was first opened being the arrangement?—That is my view. The evidence in regard to Liverpool was a proof of the advantage to be derived from the central arrangements.

You spoke of the absorption of air?—The diffusion of air.

Is it true that gas not only escapes, but air always comes in?—Always; but minute diffusion is a question of time.

My experience is this: If I am in town for a long time, and I go back to the country and turn the tap on, the gas does not light until it has been on a certain time?—That is due to the diffusion of air.

I presume that, to a greater or lesser extent, this process is going on in all fittings?—It is in the fittings where it comes in.

Are leaden pipes more subject to this than iron ones?—I do not think so.

Are they less?—It is a question that has never occurred to me before.

I was asking you, because I take it that fittings in houses are principally lead, whereas outside the meter they are invariably iron?—Yes.

As a scientist, would you consider it satisfactory to take a test in a board-school, in a room like this? Suppose they have a true sample by going beyond the meter, that there are two windows, that they draw down the blinds, and that it is dusk or just approaching darkness outside, would you think the modicum of light in the room would be, not from a scientific, but from a commercial point of view, an appreciable element?—Undoubtedly, it would be.

Your conclusion, as a scientist, is this: That justice between the gas producers and gas consumers will be better secured by a proper scientific investigation, both as to the quality of the gas drawn for the purpose and as to the conditions under which the tests are made—it will be better in the public interest that this should be done under the conditions you set out than under the more or less uncertain conditions with the 6 or 9 per cent.?—That is a very difficult question to answer. It probes the whole matter to the bottom. I think you must define the limits you are going to give the Companies after examination and observation—as to whether it should be 9, 10, or 12 per cent.

You say the best method of all is to eliminate the uncertainty, and then to proceed on strictly scientific lines, and penalize on a very small margin of defection from the standard?—Yes. What is done now is the most rigid, the most severe, and the most certain; but if you are going to change the conditions, I say you can only do it after experiment and observation as to what allowance should be made under the new conditions.

This concluded the evidence for the Gaslight and Coke Company.

Mr. Pope then addressed the Committee for the Company. He said they were engaged in the business of practical legislation; and the ordinary rules that governed parliamentary procedure should apply to the present case, as well as to all others. The Committee were asked to put a violent hand on the existing system of gas-testing. The only justification for this would be the promoters proving to the Committee that the existing system did not effect its purpose, or was not sufficient. It seemed to him that the measure was an ill-conceived one, on the face of it. It showed traces of the desire on the part of the London County Council to harass the Companies rather than to harbour an intelligent appreciation of the interests of those they professed to represent—the gas consumers. The County Council, unlike the Local Authorities of (say) Liverpool, seemed to think that gas and water and other large undertakings would be better in the hands of the public body than in those of private companies. But the Committee had to look to what was proposed in the Bill. In the preamble, the promoters said: "Whereas it has been found that the illuminating power of the gas supplied by the said Companies in their districts generally cannot be satisfactorily or sufficiently tested by tests made only at certain prescribed testing-places: And whereas it is desirable that powers should be given to the Gas Examiners to make additional tests of the illuminating power of gas elsewhere in the districts of the said Companies, in manner to be prescribed by the Gas Referees." This indicated the view that the quality of the gas supplied to the public was not satisfactory. Well, the Company under the Act accepted responsibility for the supply of gas of the statutory quality. They accepted responsibility for the quality of the gas in what was called the "flowing main;" but they did not hold themselves responsible to see that every consumer received at his burners 16-candle gas. The Act regulating their procedure required that 16-candle gas should be supplied at the fixed testing-stations.

The Chairman asked if it was not the fact that the number of candles stipulated for in the various Acts varied from 12 to 20.

Mr. Pope replied in the affirmative. The illuminating power required by the Liverpool Act was the highest; the number of candles being 20. The illuminating power varied according to the accessibility of cannel coal to the producing agency of the gas. Cannel coal was the enriching agency used formerly; and it was only recently that other materials had been adopted, which others were, perhaps, not of so stable a character as cannel. The Company recognized their liability as to the supply of 16-candle gas; and the object of the Bill was to amend the machinery by which the performance of that obligation was to be secured. So that he had no need to discuss at any length the nature of the obligation resting on the Gas Company. The question was whether there was any immediate necessity for changing the system of enforcing it, so as justify the new legislation. No Committee of Parliament, he maintained, would change an existing state of things, unless there was a manifest reason why the change should take place. Therefore, they would consider whether the system of a fixed testing-station, with all the machinery employed, had failed to secure the desired result—viz., that of securing that 16-candle gas was supplied at all the fixed testing-stations. He did not think he should be justified in saying that the work of the Gas Referees was not of a satisfactory character. All he would say was that a good deal depended on the practical knowledge of the Referees. And here he must point out that they had not had the advantage of having on the body of Referees a Gas Engineer, since the retirement of the late Mr. Evans. Well, what was the evidence? To justify legislation, the Committee should have proved before them not only want of legislation, but the efficiency of the legislation proposed. Before the Bill was passed, the Committee should be satisfied that the measure would do what the existing system did not do. The enacting part of the Bill said, in clause 3: "Any Gas Examiner may at any time make, at any place within the district supplied by any of the Companies, tests for ascertaining whether the illuminating power of the gas supplied by such Company at such place is that required by law." Then it dealt with the apparatus, and said: "The apparatus to be employed in such tests, and the mode of conducting

such tests and recording the results thereof, shall be from time to time prescribed by the Gas Referees; and the Gas Referees shall from time to time make regulations with respect to those matters, and shall send to the Council, the Corporation, and each of the Companies a copy of such regulations." In what single respect did these proposals differ from the existing system? A Gas Examiner could examine anywhere; but he could only do it subject to the decision of the Referees as to the apparatus to be employed, the mode of applying the test, and the class of places at which it should be applied. What was the use of such legislation as this? What was the use of encumbering the Statute Book with an enactment which would alter the law so little? The Referees had power to fix the testing-station anywhere, and to order the Examiner to make a test at any time they chose. The Bill was, therefore, unnecessary. But beyond this, it was vicious, because it introduced into a Penal Act of Parliament, an item of uncertainty which would, unless corrected, work injustice. The only alteration that would be made in the powers of the existing Gas Referees by the Bill, would be one for the worse, because it would introduce an element of greater uncertainty in the result than existed at present, and therefore an element of greater danger to both the consumer and the Company. The Company would not object to any such arrangement between themselves and the public authority, as that which existed at Liverpool. They would not object to tests being made by a portable photometer, if the result were to be that they would receive reports, and that the information obtained, though not strictly accurate, would be given to the Company for their guidance—to enable them, it might be, to remedy something that had gone wrong in the process of manufacture. But when it was proposed to exact penalties, the element of uncertainty made the thing unjust. The Companies did not object to being under obligation to supply 16-candle gas, and to being under a penalty if they neglected to do it, provided the illuminating power of the gas were ascertained in a satisfactory manner. They preferred to be left under the liability at present resting on them—that of the existing system of testing, which, after all, was the most certain and regular, and the most to be relied on. Manifestly, unless they could settle the amount of corrective allowance to be made in the testing, the case for the promoters showed that the Bill ought not to pass. They admitted that the element of uncertainty which existed required an additional corrective allowance to be made; but what that was, no one had yet been able to ascertain. Until it was settled, it would be unjust to submit the Gas Companies to the liability of being chargeable with breach of contract. The case for the Companies was that they gave the consumer the best protection they could in respect of the supply of 16-candle gas. He contended that this could only be ascertained with certainty and satisfaction to either side by a system involving the settlement of particular places and stations for the examination of the gas; and this contention was really borne out by the Liverpool experience, where, after "peripateticizing" all over the borough, they had settled down to fixed stations for the purpose of examination. The Liverpool arrangement, however, was not penal, but was one which gave to the Company certain advantages. It was a mutual agreement by which the Corporation should not insist upon more places, while the Company were to deal in a friendly way with the information obtained by the Corporation at these stations. If the London County Council liked to approach the Gaslight and Coke Company with any such arrangement, he pledged the Company to at once meet them, and to agree to some such plan—the County Council not to inflict penalties, but to furnish information which would enable the Company to remedy defects. In the interests of the Company, as well as in those of the consumer, the Committee should not pass this Bill, or any modification of it, because it involved the infliction of penalties by reason of the existing system not having been efficient, and the substitution of a still more inefficient system—one involving a greater amount of uncertainty, and therefore greater injustice.

The CHAIRMAN: I should like to make one suggestion. The Committee feel that they have already had abundant evidence on the subject of the portable photometer—scientific evidence as to the conditions, &c. We are saturated with evidence on that subject. We would therefore suggest—we merely make the suggestion, and leave it to your discretion—that in taking the South Metropolitan Company's case you should limit yourself to such matter as constitutes the difference between your own Company and the Company whose case we have just heard. The general matter of the question before us is already in our minds. If you have any point in which your own interests vary, or are differently affected by the proposed Bill, other than the interests of the Company whose case we have already heard, we should be glad to hear it; but I should like you, if you can, without prejudice to your Company or injury to the case, to limit it to those points.

Lord R. CECIL: It is a little difficult to be quite certain that in the evidence I shall call I am not repeating anything; but I will do my best.

Mr. *George Livesey*, examined by Lord R. CECIL.

Witness, in opening, said he wished to clear the memory of a man who had gone beyond all gas testing. He referred to a statement by Mr. Dibdin in regard to three occasions on which sulphur had appeared in the gas; the inference being that the gas had been "dodged." The explanation was that at the works concerned—those at East Greenwich—they made three times as much gas as was used in the district; the result being that, while the Company were actually bad in respect of sulphur on one day, it appeared that they were bad on three days. It was inevitable, and was not done to "dodge."

The CHAIRMAN said the impression left on his mind had been that if dodgery had been intended it would be possible.

Witness: It is our misfortune. Continuing, he said that he entered the service of the South Metropolitan Company fifty years ago, and in 1871 became Secretary, as well as Engineer. In 1882, he went on the Board; and since 1885, he had been Chairman. The photometric examination of gas was not an exact science—a mathematical operation. The illuminating power varied according to the method of testing.

Lord R. CECIL: The variations in the value of the gas depend upon the conditions under which it is tested?

Witness: Quite so. That is why the conditions are specified.

The CHAIRMAN: I suppose you mean, not that the illuminating power varies, but that the ascertained illuminating power varies under the conditions in which it is tested.

Lord R. CECIL: That is what I mean.

Witness: I am afraid the illuminating power varies too. It is impossible to make gas of perfectly uniform quality. It varies within certain narrow limits.

The CHAIRMAN: I take it that the margin which is allowed under the Act is indicative of general consciousness, at the time the investigation was made and the candle power determined, that, practically speaking, mathematical accuracy in the production of gas was an impossibility.

Lord R. CECIL: Yes.

The CHAIRMAN: Therefore a margin was allowed to make provision for that uncertainty. If it were mathematically possible to make gas of precise illuminating power, you would never go one decimal point above the prescribed power.

Witness: Quite so.

Lord R. CECIL: In addition to the operation connected with the manufacture of gas, a certain loss may take place in consequence of its passing through small mains, for instance, or mains that are not in good condition?

Witness: Yes. Deposition took place at some times and not at others; and a good deal of that which was deposited would be pumped out of the mains.

I think you are Chairman of the Crystal Palace Company?—Yes.

There, I believe, you have had some experience of the curious effects that may be produced on gas?—Speaking broadly, the gas supplied at Beckenham is tested 2 miles from the works. Sometimes there is a diminution of $\frac{3}{4}$ candle, and usually of $\frac{1}{2}$ candle. At other times, there is an increase—the gas is better at Beckenham than at the works.

The CHAIRMAN: Arising from the circumstances you are now describing?—Exactly.

Lord R. CECIL: Thus what Mr. Vernon Harcourt said is quite true—it may pick up illuminating power?—Unfortunately, if we lose something to-day we are penalized; we do not get the credit of its being better to morrow.

Those facts are very well known, and have been well known since 1860?—Yes.

I think you are familiar with the proceedings that took place before the Committee on the Metropolitan Gas Act of 1860?—Yes.

Do you remember the evidence that Dr. Letheby gave?—Shortly, Dr. Letheby made a number of experiments on the gas supplied to the City from the Bow Common works. He was Professor of Chemistry at the London Hospital; and he made tests there and in the City, and found there was a loss of 2 candles between the works and the City. He found also that the greater part of the loss took place between Bow Common and the London Hospital. I think the conditions were rather adverse, because there ought not to be a loss of 2 candles in that district.

The method of testing adopted in 1860, and since enforced on the Companies, was adopted with a view to these irregularities of gas which were well known at that time?—Yes. Parliament had distinctly recognized the fact that gas under certain circumstances did lose in travelling, for in the Pendlebury and Salford case they enacted that the gas, which was to be 18 candles at the works, need only be 17 candles in the district.

Was it in 1860 that this system of gas-testing stations in London was established?—It came about in this way: Prior to 1853, competition was universal, and there was no trouble taken about gas-testing stations. In 1853, the Gas Companies supplying South London, and in 1858 the Companies supplying the North, amalgamated. Parliament legalized the arrangement; and, that being so, it was felt that protection was necessary for the consumers. This was the first time, I think, an Act was passed requiring gas to be tested.

Was it pointed out that frost and stagnation also had an important effect on the illuminating power of gas?—Yes; by the Act of 1860 the testing-stations were fixed at 1000 yards, as near as may be, from the works. In 1876, that provision was repealed, because in the interim the Beckton works had been built.

The CHAIRMAN: In other words, the central area of London said: "We must have the 16-candle gas on the spot, though you may have the works miles away?"

Witness: Yes.

I suppose you would agree that the high-pressure service from Beckton in the 48-inch pipes, with the strong currents, is a distinct advantage to that Company in securing the maintenance of the quality of the gas at a distance?—I have tried to make a calculation on that point. The condensation and reduction of illuminating power is due to the contact with the surface; and I came to the conclusion that in a small main there is 150 times as much contact with the surface as in these big ones, because they send through such large volumes.

Lord R. CECIL: As a matter of fact, I think the testing-stations in your Company's district are about 1000 yards from the works?

Witness: The Referees have still acted on the principle of placing a testing-station on the leading mains, in order to get samples of the bulk of the gas; and in five out of our six stations that is so. In the case of the Greenwich works, we have one station on a 3-inch main.

When were the gas-testing stations first established—the system of having testing-stations for each Company?—I think we were the first to do it. We did it voluntarily in or about 1860.

Since 1860, substantially, has the principle for testing London gas always been the same—I mean in a station prepared for the purpose?—Always.

And all the capital subscribed for the Gas Companies in London has been subscribed under that condition?—Yes; and everywhere else, as far as I am aware, except at Liverpool.

Do you think that the portable photometer would be a fair way of testing your gas?—I think if the portable photometer were adopted, it would render the position of gas managers perfectly intolerable. I was Engineer from 1869 to 1882; and in the first part of the time our quality was 14 candles, and we were able to supply 16 candles without any trouble. But after we were put up to 16 candles in 1876, it was an anxiety every morning when we went to the works to look at the test-papers. If the portable photometer were adopted, the position would be so intolerable that I do not know what we should do.

The CHAIRMAN: I suppose it is a crucial point?

Witness: It is not a crucial point; it is all nonsense. The gas was just as good when there were no tests as it is now. The crucial point is whether the consumers shall have gas at all—not whether it shall be a candle more or less. The largest gas-works in London were recently

within six hours of exhausting their supplies of coal. We have been hovering for weeks on two days' supply; and what we are to do this year, I do not know.

Lord R. CECIL: I want to get it clear what your objection is. It is not to the instrument itself, but to its being carried about?

Witness: The instruments are the same. The conditions under which they are used are undesirable. I cannot add anything to Professor Dewar's evidence.

You admit that you are bound to supply 16-candle gas?—As defined by the tests. I have always regarded it as our obligation that we should supply good 16-candle gas from the works, and the orders of the Directors to the Managers have been to give this full 16 candles. On one occasion, there was a deficiency in the gas from one station. An extract from the minutes of the Board meeting of Dec. 19, 1888, stated that the Engineer reported the official tests during the previous week, some being bad. The Board regarded this report, the minute went on, with great dissatisfaction, and ordered that the attention of the official concerned should be directed to the instructions given repeatedly to the Managers of the stations that their first duty was to take care that the quality of the gas was maintained above 16 candles, whatever the quantity of cannel required for the purpose. The Company always sent out gas of over 16-candle power. He had never understood that they were to supply 16-candle gas to every consumer, but that it was to be 16 candles as sent out from the works, and that gas of 16-candle power was to be found at the testing-stations. He also understood that Parliament knew there would be a diminution due to the gas having travelled.

What you have always understood is that, where the gas can be fairly considered to be in bulk (that is, in the leading mains), it must be 16 candles?—Yes.

But when it gets into the small by-ways of your system, you do not regard yourself as under obligation as to the 16 candles?—Yes.

By the CHAIRMAN: He believed the South Metropolitan gas was ½ candle lower than that of the Gaslight and Coke Company; but the policy the South Metropolitan Company had pursued had been rather different from that of the Gaslight and Coke Company. The South Metropolitan Company's policy had been to give consumers an abundant supply of gas at the lowest possible cost. The price was a consideration; and the result was that they had been able to sell their gas at a very much lower price than their neighbours.

Lord R. CECIL: Do you differ from the view expressed here, as to the obligation on the Gas Companies, by the Gaslight and Coke Company?

Witness: As I read the Act of Parliament, I do not agree. It is to be 16 candles tested in the ordinary way; and Parliament, in making the provision, knew that it would be less in the district.

The CHAIRMAN: That is purely a matter of your opinion?

Witness: That is so. My opinion is that if Parliament had intended 16-candle gas to be given everywhere, it would have required us to supply 17 candles.

Lord R. CECIL: If such a system as the portable photometer were put upon you, would you, to be safe, have to make a very much higher quality of gas?

Witness: We should not be safe unless we sent out 19-candle gas.

What would be the effect upon the consumer?—In the first place, a good many consumers would get 19 candle gas, and we should have any number of complaints of the smokiness of the gas and of the headaches which it would produce. If you have a rich gas supplied where they have been accustomed to a poor gas, it does not get properly consumed, and there is a great deal of smoke. If the combustion is not quite complete, you have a quantity of carbonic oxide, and that is the real cause of headaches, I believe, in schools. That is the effect on the consumer. The other effect would be to enormously increase the cost of making gas. We should have to raise our price at least 3d. per 1000 cubic feet. This would add £126,000 a year to the consumers' charges. It would not take anything from our dividends. We are entitled to a much larger dividend than we have been paying. We have been paying on a dividend due to a price of 2s. 1d., whereas we are entitled to a dividend due to a price of 2s. 5d. He added, however, that this year they would have to lose dividend.

Have the consumers asked for an increase in the illuminating power of the gas?—No.

I think that is an important matter?—Very little has been said about the consumer. The County Council said they were moved by complaints from various consumers; and on application they furnished some particulars going back to 1891. These complaints were contained in letters from the Vestries of Battersea and Rotherhithe, the Lee District Board, and a Mr. John Burgess, a resident in Lavender Hill, who asked earnest attention to the quality of the gas, and said its lighting power had been very poor, and that it made his eyes ache to read by it. The Company had applied to the districts for the details of these complaints, but could not get them.

The CHAIRMAN: May I ask whether in this Lavender Hill complaint you have made any investigation as to the fittings, or anything of that sort?

Witness: I cannot say. I have got a number of our own complaints, which we have investigated. Sometimes we have to tell the people that it is the fittings, sometimes it is a stoppage in the service.

Lord R. CECIL: Was this complaint of John Burgess forwarded to you by the London County Council at the time?

Witness: No.

So you could not possibly make any inquiry?—No. Continuing, he said that in the week ending Jan. 27 last, out of the Company's 200,000 customers they had about 700 complaints. There were 68 of bad light, 143 of bad supply, 148 of no gas, 97 requesting the Company to see to the gas, 175 requesting the Company to see to the meter, 9 of bad gas, 3 of gas burning badly at stoves, 23 of lights jumping, 7 of low pressure, 9 requests for clear service, and 6 requests to blow the pipes. In one case, the Company took away the burner and found that with 16-candle gas it only gave a light of 11¾ candles. He put in a table of 49 instances in which burners had been tested under the best conditions with 16-candle gas; the result being to show a power varying from 16·9 to 6 candles. The defect was always due to faults in the fittings, naphthalene in the pipe, something wrong with the pressure, or something of that kind. As regarded the pressure, very often gas was laid on in a house for a certain number of burners, and then a gas-stove or more burners were connected, without any alteration of the pipes—the result being a greatly diminished pressure. It was no uncommon thing to find a considerable quantity of naphthalene in the service-pipes. He had suffered from this in his own house; naphthalene having been deposited in the pipes while no such thing happened in the pipes of his neighbours.

The actual tests under the most favourable conditions by photometer show considerable variations of this nature?—Yes.

I believe that three separate tests are taken on each occasion, and that each test consists of ten observations?—Yes.

So that you get thirty observations to make one series of tests?—Yes.

And these observations differ considerably from each other?—That is so; and the three tests themselves differ very materially.

Give us a case?—From the East Greenwich works we supply Woolwich and Plumstead; and no other gas whatever by us supplied reaches those districts. The testing-place is at Burridge Road. During the last twelve months, we have taken out three tests there. The first gave 15·6 candles, the second 16 something, and the third 16·6. There was an interval of one hour between the second and the first, and of two hours between the third and the first. It was impossible that there could be any difference in the gas, though the first test showed 1 candle less than the others. This would prove that the first test was not a fair one; the results being better after the gas had been burning one hour and two hours.

The CHAIRMAN: I understand, from the diagram, that the testing-place is on the 10-inch main?

Lord R. CECIL: That is so.

Witness: At the Bloomfield Place Board-School, we made a test on May 3, 1894, when we supplied unenriched gas. The test showed 13·9-candle gas; and on the same day the same gas at the official testing-place gave us 15·7, or a difference of 1·8 candles. It was impossible, in that case, that the gas could be different at the two places. The same thing was observable with enriched gas. We got 15·6 candles at the board-school, and 16 candles at the official testing-place.

Lord R. CECIL: Can you put before the Committee your views as to the desirability of enriching at all?

The CHAIRMAN asked whether that evidence would appertain to the Bill.

Lord R. CECIL said he would not press it, if the Chairman did not think it desirable.

The CHAIRMAN said he did not think about the matter at all; he only asked the question.

Witness said he would deal with the point very briefly. He held that all the trouble that was engaging the attention of the Committee was caused from excessive enrichment; and the portable photometer did not adequately deal with the matter. It had given enriched gas at 15 candles and unenriched gas at 14·85. This was testing the portable photometer against itself. The observations he would make in regard to enrichment were these: There were several methods of enrichment. There was, first, that of using cannel coal. Cannel coal was not to be had now; its price was prohibitive. It was cheap enough at the present moment, no doubt; but this was because the Gas Companies had ceased to use it. If the Companies started to employ it again, no doubt the price would go up. The other methods of enrichment were by pretroleum spirit and carburetted water gas. Pretroleum spirit was a vapour which was put into the gas by means of steaming out; and it was more likely to condense out of the gas than carburetted water gas. It was possible that when it was put in at one end of a district, by the time the gas reached the other end the pretroleum spirit would be gone, and have taken something else away with it. At his works, they had not adopted water gas. No doubt enrichment by means of cannel coal was perfect.

The CHAIRMAN: In the case of petroleum spirit, it is a mechanical mixture of two different substances?

Witness said that was so; and they could not be certain of it. His experience of enrichment was that it was a sheer waste. The consumer had to pay for it, but would be much better without it.

The CHAIRMAN said that they no doubt had heard Mr. Livesey's views, not only there, but outside the room. He doubted, however, whether this evidence was relative to the question before them. At any rate, they need not go too elaborately into it.

Lord R. CECIL remarked that he did not propose to do so.

Witness went on to say that his Company understood they were bound to supply a good 16-candle gas when tested at the station; and 16-candle gas was sent out of the works in sufficient bulk to give 16 candles or a little more at the testing-stations.

Lord R. CECIL: It is not a fact that you supply a special kind of gas at the testing-stations which does not go to the consumer?

Witness: Certainly not. Some people suspect that we do; but we do not. I think that even the Gas Referees suspect it, having regard to their last order.

But it is not done?—No; we have never done it, and have never thought of doing it.

You do not manipulate the gas to produce a better result at the time of testing?—No; in five cases out of six we do not know when the test is to take place.

The CHAIRMAN: You do not attend them.

Mr. EMMOTT: How long would it take your gas to travel from the works to the Burridge Road testing-station?

Witness said he could not answer the question; but it would be some hours.

The CHAIRMAN: It would be freshly-made gas, but would go to the testing-place from the holders?

Witness: That is so.

You never clear out the whole of the holders?—We do not clear them. Continuing, witness said he had once a singular complaint—namely, that the gas in a certain district went out—and on investigation it was found that it was owing to trouble with a purifier. It was discovered that, in clearing it out, the air had not been got rid of, and that 2000 or 3000 feet of air had got into the works. At the Bankside testing-station, they had obtained tests by the photometer showing variations between 15 and 17 candles; and they could not always help it. Though they were enriching the gas up to 17 candles at the works, it would sometimes be 15 candles at Bankside. They supplied from these works 2 million cubic feet per day, or 4 per cent. of their total output. When the tests showed such variation, there must have been some disturbing cause. At the time of the low test, they were experimenting with different kinds of coal. The gas

did not go from a holder at Bankside to the consumers, but straight from the works. They sent gas to the holder at Kennington in the daytime; but at night they wanted all they could get for the consumers.

The CHAIRMAN: Have you had complaints from the inhabitants in the neighbourhood of the station?

Witness: None at all.

Lord R. CECIL: Is it not a fact that the illuminating power of the gas is not now-a-days so important as it used to be.

Witness said that was so, because formerly gas was used for lighting purposes only, but now 50 per cent. or more was employed for heating. The Welsbach burner was coming very commonly into use; and for this a poorer quality of gas was suitable.

Mr. EMMOTT: Looking at your diagram, I see that 2-candle power gas is said to be better for purposes of this illumination than 13-candle gas.

Lord R. CECIL said he understood that the nearer approach they got to pure carbon, the greater the heating power of the gas; and as the illumination of the Welsbach burner was caused by the heating of the mantle, a lower quality of gas gave the better results. (To witness:) Do you think this is a favourable time for throwing fresh burdens on the Gas Companies?

Witness said it was a very bad time. Every burden thrown on the Companies really fell on their partners, the consumers.

Cross-examined by Mr. TALBOT: His Company had not had many proceedings for penalties brought against them. There had been none in respect of the fall in the illuminating power of the gas at the Bankside station of which he had spoken.

Mr. TALBOT: Have the tests at that station always given satisfactory results?

Witness: Not so satisfactory as at other stations.

At any rate, they have given satisfaction?—Yes; but they fluctuate more than we like.

How do you put things right when the test shows a low illuminating power?—We enrich the gas with petroleum spirit; and we are constantly doing that, and watching the gas from time to time. We have a test flame always burning; and according to the results we get from that, we enrich or not as is required. Sometimes we enrich too much; and in that way the flame is constantly going up or down.

You secure a satisfactory gas by enriching at the works from time to time?—Yes.

What is the distance from the works to the testing station?—Three-quarters of a mile.

How soon can you rectify a fall in the illuminating power of (say) ½ candle?—We have found that when the full supply of gas was on, we could do it in a little over half-an-hour.

The late Mr. Stevenson, in 1875, said his experience was that the illuminating power of the gas could be changed quickly. He said that he himself would undertake to change it from the Beckton works to the first testing-station, which was 1000 yards away, in 20 minutes?—He never had that experience. He did not do it, and could not have done it. He was a good Gas Engineer, but was not a practical gas man. The only method of enriching then was by cannel coal; and this had to be put into the retorts. Spirit enrichment was not known at that time.

Mr. Stevenson was asked about his previous experience; and he spoke of experiments made at Uxbridge, in 1855. He had checked the illuminating power of the gas as it was going into the town?—Yes. He was speaking of the works at Uxbridge, which you could have put in your hat; and was comparing them with works which Hyde Park would not hold. I have no doubt he could alter the illuminating power at Uxbridge in 20 minutes. On our system, we never tried what could be done in this respect until last week, when we made an experiment at Bankside.

Do you know that Dr. Clowes and the others who conducted testing experiments at Bankside about which evidence has been given were not aware beforehand of the fluctuating state of things existing there?—They did know of it.

Will you take it from me that they did not know of it?—Certainly. But the County Council had an idea where the greatest irregularity was to be found; and, like true sportsmen, they went where they were likely to meet with game.

Take it from me that they happened to stumble on the place where these irregularities existed?—Then I take it from you they did stumble on it. Continuing, witness said that when the enriching process was carried out, it was effected, not by the Manager of the works, but by a workman who acted under orders and turned on the enriching material according to the fluctuations in the flame at the Company's testing-station. The directions issued to the workmen were that a good 16-candle gas was to be sent out of the works. The gas sent out was usually 16½, and sometimes 17 candles.

Would you regard it as impossible to enrich the gas so as to comply with the parliamentary requirements at the testing-place?—I should consider it impossible. It would be contrary to the orders of the Company if a man were to enrich the gas at one station and nowhere else.

Witness was asked whether it was not his theory that at a distance from the works a smaller candle power should be exacted than at a station near the works; and he replied in the affirmative. He added that if the Referees fixed the testing-station at the extreme end of a main, which they had power to do, he should regard it as very unfair. If the Referees fixed the testing-station at the end of the main in a wide district, and insisted on having 16-candle gas, the Company would point-blank refuse to supply it.

Mr. TALBOT: Whatever the standard, we desire that it should be ascertained at a point near where it reaches the consumer, and not at a fancy place.

Witness said that this matter had been gone into fully; and it had been shown that there could be no certainty as to the quality of the gas as it reached the consumer. Forty-nine per cent. of the County Council tests had been made in the daytime. This could not be fair, as it would not be at a time when there was a full flow of gas.

Mr. TALBOT: The Referees would prescribe the time?

Witness: Then I must talk a little about the Referees. The Board of Trade have deliberately ignored the requirements of Parliament as to appointing among the Referees a practical Gas Engineer. I have been to them more than once, and made representations to them as to what they were doing. Not one of the Referees has ever had any experience or knowledge of the manufacture or distribution of gas.

Why do you not mandamus the Board of Trade to get a proper man?—We may come to that. The appointment of the Referees has been an unmitigated disadvantage to the consumer. It was thought, when they were appointed, that their jurisdiction would be extended; but they have never gone beyond London. They have done no good.

I gather that you object to the machinery that Parliament has thought fit to set up?—I do not object to the testing. We want a free hand to fight our competitors. Depend upon it, if the restrictions were removed the Gas Companies would supply the best gas the consumers could desire. If they did not, the consumers would leave them.

So that you would prefer that the whole matter of the illuminating power of the gas should be left to the Companies. Your contention is that these portable tests increase the obligation on the Companies, because they are not trustworthy?—I say that in all gas tests there is a great element of uncertainty; and when you introduce the portable photometer, you make the uncertainty still greater.

Do you say the portable photometer is open to greater objections on that score than the fixed photometer?—Yes.

How do you account for the fact that at Liverpool tests taken for four years by this method have coincided, within a minute fraction, with the official tests?—I understand the portable photometers are in fixed testing-places.

No?—Then I may say the Liverpool case is different from ours. Witness went on to explain that in Liverpool they made over 21-candle gas from a mixture of coal and cannel, and supplemented it with water gas of 21-candle power, so that there was no mixture of qualities. Unenriched gas in London was of from 15 to 15½ candle power; and the enrichment which was added was of different quality. The circumstances under which gas was tested with the portable photometer were not fair; and then the method of enrichment by petroleum spirit was not certain and safe.

The remedy would be to do without the enrichment, and have a lower standard; and if this were done, it would meet your objection?—Yes; and then I say there would be no necessity whatever to test anywhere except at the works. The gas would be of uniform quality, and it would always lose a certain known amount.

As a matter of fact, is it the case that an ordinary consumer's burner would only give 11 candles illuminating power, with gas which with the statutory burner would give 16 candles?—The table produced shows that the ordinary burner gave from 6 to 17 candles.

Take 16-candle gas, as tested, would that give 17 candles with an ordinary consumer's burner?—It did so in one case. Speaking generally, the burner in ordinary use (the flat-flame burner) was a good one. One of Bray's or Sugg's burners would give 16-candle gas, perhaps 2 candles less; but if you get down to 11 or 12 candles, you have got bad burners.

Re-examined by Lord R. CECIL: The Company had found out that they could carry gas considerable distances without alteration, if in large mains.

Lord R. CECIL: It was the discovery of this fact which induced Parliament to do away with that safeguard—the provision of testing-stations 1000 yards from the works?

Witness: I believe it was done away with by agreement. The Companies raised no objection.

That was largely because of the experience they had had?—Yes.

The reason you brought that before the Committee was that from the very outset Parliament recognized that the gas to be tested was not necessarily to be the gas as supplied throughout the district?—Quite so. In the Salford case, it was put at 18 candles at the works, and 17 in the district.

It has been suggested that the portable photometer should be applied in board-schools. Would this secure fairness?—Mr. Vernon Harcourt said that nearly always board-schools were on the main thoroughfares. If you look at the plan, you will see that, out of about twenty, only four, I think, are on main thoroughfares; the others are in back streets. Board-schools in themselves, I believe, are most unsuitable places; and the mains from which they draw gas would not be fair.

By Mr. LEIGHTON: The Company held it to be their duty to keep the service-pipes clear from the main up to the meter. With the ordinary consumer, the Company supplied the meter, but had no responsibility with regard to it. He objected to the enrichment of gas, and thought petroleum spirit used for the purpose spent itself to some extent with the lapse of time.

Mr. LEIGHTON: You disapprove of all testing?

Witness: No; I will not go as far as that. I say it has been of no benefit to the consumer.

You are acting entirely in the interests of the consumer, because the consumer will have to pay the costs, and not your Company?—Well, I have here what I said 25 years ago: "I contend that the interests of the Gas Companies are so closely bound up with the interests of their customers, that their interests are identical." Continuing, he said on an average the South Metropolitan Company had one fine a year imposed for the gas not being up to the standard.

The CHAIRMAN: You say that your penalties have not been numerous?

Witness: No.

But you are not so immaculate as the Gaslight and Coke Company?—We are about the same, I think.

Out of 20,000 tests, they have only had two cases of penalties?—I do not think we have had more than two or three in the last few years. The best form of enrichment was cannel coal. Water gas would cost more than his present form of enrichment. He believed petroleum spirit was satisfactory. The difference would not be taken account of practically.

And the condensation, assuming it does take place, is confined or obtains principally in the small mains?—Yes; and it depends on the weather.

You do not think an enriching method which so loses its effect in travelling is a fraud upon the consumers?—No; it is not a fraud upon the consumers. There is nothing but water gas or petroleum spirit for keeping it up.

Do you think that the stations now in use in the Metropolitan area are sufficiently representative of the various conditions of gas in the localities?—I think they get a fair sample of the gas.

The Committee then adjourned till Monday (yesterday).

HOUSE OF COMMONS COMMITTEE ON POLICE AND SANITARY REGULATIONS BILLS.

Tuesday, May 1.

(*Before Lord* E. FITZMAURICE, *Mr.* H. BEMROSE, *Mr.* BILL, *Mr.* HEYWOOD, *Mr.* JOHNSTONE, *Mr.* LEUTY, *Mr.* M'KENNA, *Mr.* H. J. WILSON, *Mr.* J. W. WILSON, *and Mr.* WYLIE.)

BRADFORD CORPORATION BILL.

This Bill, which is to authorize the Corporation of Bradford, among other things, to acquire land for the protection of their water supply, to purchase the undertakings of the Clayton, Allerton, and Thornton Gas Company, and the North Bierley, Eccleshill and Bolton, and Airedale Gas Companies, and to purchase gas from the Drighlington and Gildersome Gas Company, was further considered (*ante*, p. 1008) by the above-named Committee to-day.

The following Counsel were engaged in the case: For the promoters, Mr. BALFOUR BROWNE, Q.C., Mr. FREEMAN, Q.C., and Mr. WAUGH; for the Drighlington and Gildersome Gas Company, Mr. WORSLEY TAYLOR, Q.C., and Mr. GERALD FITZGERALD; for the Airedale Gas Company and the Clayton, Allerton, and Thornton Gas Company, Mr. J. D. FITZGERALD, Q.C., and Mr. MOON; for the North Bierley Gas Company, Mr. WEDDERBURN, Q.C., and Mr. H. LLOYD; and for the Eccleshill and Bolton Gas Company, Mr. CLAUDE BAGGALLAY, Q.C., and Mr. LLOYD. In the case of other petitioners, Counsel were reserved.

The CHAIRMAN asked if there had been any result of the suggestion which the Committee threw out at the last meeting that the parties should come to an agreement regarding the gas clauses of the Bill.

Mr. FREEMAN said he was just about to ask leave to make a statement with reference to what had happened on the question of the purchase of the Gas Companies since the Committee rose. Of course, after his Lordship's statement at the last meeting, the Corporation's advisers immediately addressed a communication to the Airedale, Eccleshill, and Clayton Companies, asking representatives to meet them and discuss the terms of a possible settlement. As he announced to the Committee on the last occasion, they had already come to terms with the North Bierley Company. These terms had been embodied in a proper agreement which had been exchanged between the parties; and the North Bierley Company were therefore satisfied. After writing this letter, they received an answer from the Airedale, and one in very much the same terms from the Clayton Company, which surprised the Corporation very much, because it practically came to this: They both said that Mr. Stevenson (who the Committee would recollect was one of the witnesses for the promoters) had negotiated certain terms, as they understood it, on behalf of the Corporation, which they considered binding, and which they were prepared to carry out. That was the first time the Corporation had heard of anything of the sort; and they immediately wrote to the Companies, and said that there was some complete misunderstanding; that Mr. Stevenson was not in a position to negotiate anything final, and all they understood was that the Companies had made certain suggestions, which they were prepared to accept, and Mr. Stevenson had forwarded them to the Corporation; and that the Corporation were perfectly prepared to discuss the matter, and hoped to come to some arrangement. The reply to this was that the Companies considered that the Corporation were going back on something which their agent had negotiated; that they would leave the correspondence with the Committee; and that they declined to further discuss terms. There the matter ended. The Corporation were perfectly prepared to discuss the matter, and to come to any reasonable agreement; but the Companies, on the other hand, refused to meet them—being no doubt under a *bonâ fide* misapprehension as to what Mr. Stevenson had done. Mr. Stevenson had no authority from the Corporation to settle matters. The Corporation were in that position still. They were perfectly prepared to meet and negotiate; and he submitted that, under these circumstances, the clause in the Bill should stand, which would still leave negotiation open to them to arrange terms if possible, and if they could not arrange terms, then that it should be left to an arbitrator under the Lands Clauses Act to settle the price at which the undertakings should be acquired. There could be no question between them now, except as to price, and how many years' purchase of profits should be paid. The terms which they thought Mr. Stevenson had arranged to accept were higher than the Corporation were inclined to give; but they were still prepared to negotiate. To one of the Companies—the Gildersome Company—his observations did not apply. The Corporation were not proposing to buy that undertaking, but only to take gas in bulk from them on terms to be arranged. This Company had not negotiated with the Corporation at all, but declined to have anything to do with the matter. With regard to the other Companies, the only question was as to whether they were to have a certain price or whether the figure was to be fixed by arbitration; and he asked the Committee to say that the clause in the Bill met the case.

The CHAIRMAN: Then I may take it from you that you have only succeeded in coming to terms with the North Bierley Company.

Mr. FREEMAN: That is so.

The room was then cleared, and after the Committee had been a short time in private consultation,

The CHAIRMAN said: I have to inform you, on behalf of the Committee, that we cannot agree to pass the gas clauses of this Bill. The Committee are very glad to learn that an agreement has been come to between the Bradford Corporation and the North Bierley Company; and no doubt the agreement will be put into a separate schedule and inserted in the Bill. But the remainder of the clauses we cannot pass, although we have no doubt that, with a little further negotiation, there is nothing which cannot be got over.

Mr. LANKESTER (for the Cleckheaton District Council) said that there ought to be a clause brought up to enable the Council to buy that portion of the works which was within their district.

Mr. FREEMAN said that the Cleckheaton Council asked for a modification of the clause, which he was instructed to resist absolutely.

The remaining clauses of the Bill having been gone through and settled,

The CHAIRMAN inquired if it was likely that the Cleckheaton Council and the Corporation would be able to come to any agreement.

Mr. WAUGH said they had not had the Council's clause submitted to them; but if it was what he was afraid his friend contended for, they would not be able to agree, and the Committee would have to settle the matter between them. The Corporation were to purchase the works as a going concern; and then the Council sought to repurchase that portion outside the city, not as a going concern, but simply as old metal.

The CHAIRMAN said if that was the case, as much time as possible ought to be given to permit of the parties coming to an agreement. The further proceedings would therefore be adjourned.

Wednesday, May 2.

When the Committee sat this morning, the agreement between the North Bierley Company and the Corporation was submitted, by which it was provided that the Corporation should pay to the Company thirty years' purchase of the maximum statutory dividends, and take over the mortgage loan of £11,375. The Company are to pay the costs of the opposition to the Bill, and the winding-up expenses, out of a reserve fund of £2000 which is invested in the undertaking.

Mr. FREEMAN, addressing the Committee, said that the Corporation had agreed with the Company for the purchase of the undertaking as a whole, at its fair commercial value. The District Council of Cleckheaton sought to purchase the portion of the concern within their district, which was a very reasonable thing; but instead of re-purchasing on the same basis of commercial value which the Corporation paid, they asked to be allowed to do so by paying merely for the value of the pipes and mains. On the broad ground of justice, this was perfectly unreasonable; and he urged that there was no reason why they should not pay on the same basis of value as the Corporation had to pay.

Mr. LANKESTER said it was in the interest of small local authorities that they should be allowed, on the best possible terms, to come in and get control of their gas and water; and for many years the Model Clause had provided for the local authority buying such portion as laid within their district upon the basis of the value of the works and plant without regard to its profit-earning value. This was the clause which he asked the Committee to insert in the Bill. He admitted that in many cases, attention having been drawn to the hardship of a local authority buying at the mere price of plant and works, when the original purchasing authority had paid for profit-earning value, a variation had been made in the clause, such as putting in the word "undertaking" or that "the Arbitrator in deciding the value of the works and plant shall have regard to the circumstances under which the original authority purchased," so as to bring in some element of profit-earning value, because they had themselves purchased on that basis. But in this case, the District Council of Cleckheaton would be asked to pay a price, not for mains and pipes really, because there were none they could purchase; the pipes and mains in the district being for the supply of areas beyond. If the clause were adopted as the Corporation wished, and they reduced the price of gas within the city, they would obtain £4500 extra in rates from the Bierley district, and supply the gas at a loss or without profit. Then before the Arbitrator they might urge that the Cleckheaton district was the only revenue-earning portion of the concern; and Cleckheaton would have to pay a largely enhanced price for the portion of the undertaking within their district.

Mr. FREEMAN, in reply, contended that the usual practice was that the sub-purchaser should pay on the same basis as the original purchasing corporation paid, and that any other course would be unjust and unfair.

After consultation in private,

The CHAIRMAN said that the Committee would accept the clause as proposed by the Corporation.

Mr. LANKESTER then brought up a clause providing for equality of charge for the supply of gas within and outside the borough.

Mr. WAUGH objected that this point was not raised in the petition.

The CHAIRMAN said that, as the whole clause was practically new matter, it was not unreasonable that this question should be gone into.

Mr. LANKESTER said what he proposed was that the charge made by the Corporation should be the same to all consumers, and that no preference should be given to the consumers within the city over those outside. Such a clause had been placed in many other Acts; and it was important for the protection of Cleckheaton that some such provision should be made. Unless they were protected in this way, it would be open to the Corporation to charge a very low price within the city, while they maintained a higher price outside in order to recoup themselves for the loss that they made inside. This would be very unfair to their outside consumers, especially as there was a direct inducement to supply inside the city at the lowest possible price—or even at a loss—in order that they might be recouped by the extra rating. A similar clause was inserted in the case of the Glastonbury Bill, for the protection of the Street Urban District Council.

Mr. WAUGH said that such a proposal was not resisted by the promoters in the Glastonbury case. The effect of Mr. Lankester's suggestion would be that the Bradford Corporation would be bound to supply Cleckheaton at a loss; and then they would be able to go before the Arbitrator and say that, although the Corporation purchased on the basis of a profit-earning concern, the profit-earning had disappeared, and the basis could not be taken for the repurchase. Mr. Lankester was endeavouring, by this clause, to get round the decision of the Committee on the last clause. The value of the reduction of 10d. per 1000 cubic feet which Cleckheaton were asking for, would represent £20,300. The District Council were asking to so depreciate the value of the undertaking that, when they came to purchase a portion of it, they would practically be able to buy it for nothing. The reason why the Corporation could supply North Bierley at 2s. 1d. per 1000 cubic feet was because they were going to wipe out the existing works, and supply them from the new undertaking which they were going to establish in the centre. They never could be supplied from the existing undertaking at 2s. 1d. It was only because of the immense amount of capital which the citizens of Bradford had sunk in their whole undertaking, that they were able to furnish gas at so cheap a price; and now Cleckheaton coolly came in and sought to get the benefit of the great expenditure which the ratepayers of Bradford had incurred. He submitted that it would not be fair to compel the Corporation to supply outsiders at the same price as they charged their own ratepayers.

Mr. LANKESTER, in reply, said that Cleckheaton would have been willing to pay some slight difference of price (such as 3d. per 1000 cubic feet),

if it had been suggested that there was extra cost incurred by reason of the extra distance from the works. But it had not been suggested that there was any such extra cost. There was no reason why more should be charged outside than inside the borough; and unless some protective clause were given, it would be most unfair and onerous upon the consumers of gas in the Cleckheaton district.

The Committee, after further private consultation, decided not to accept the clause.

The remaining clauses of the Bill were then formally disposed of; and the Committee ordered the Bill to be reported for third reading.

LEGAL INTELLIGENCE.

SOUTH-WESTERN POLICE COURT.—Tuesday, May 1.

(*Before Mr.* E. W. GARRETT.)

London County Council v. Wandsworth and Putney Gas Company.

This was a summons taken out by the London County Council against the Wandsworth and Putney Gas Company for non-compliance with a notice requiring them to set back a new building to the distance prescribed by the London Building Act. It was originally heard on Nov. 14, 1899; and was dismissed. The Council appealed on the 2nd ult., and were successful; and the matter was sent back to be dealt with by the Magistrate (*ante*, p. 950).

Mr. CHILVERS appeared for the London County Council; Mr. COOPER represented the Company.

Mr. CHILVERS remarked that his Worship had already had an order from the High Court in regard to the matter before him, and said a case had been decided just prior to this one coming into Court. It was heard on the 25th of October.

Mr. GARRETT said it was not cited to him.

Mr. CHILVERS went on to say that since the decision of the High Court, nothing had been done by the defendants; and he asked his Worship to inflict a penalty under section 200, sub-section 2, of the Act, which set forth that "every person who neglects or refuses for 28 days after service of a notice requiring a new building to be set back, &c., shall be liable to a penalty of not less than 40s. and not more than £5, and a daily penalty of 40s." The summons was not for a daily penalty. He applied for costs, and reminded his Worship that he allowed the defendants 10 guineas costs after his previous decision.

Mr. COOPER asked for the infliction of the smallest possible penalty. He said the defendants had done nothing, because it was thought that the better course would be to hear his Worship's decision. The Company were applying to Parliament in the present session to stop up the two roads concerned; and the matter was absolutely before a Parliamentary Committee. After his Worship's decision, the defendants would write to the London County Council, and suggest that no further proceedings be taken until the Committee had decided the question before them.

Mr. GARRETT: So far as the present application is concerned, I shall have to inflict a penalty.

Mr. COOPER: It is a question of law, purely and simply. We thought we were right, and the Judges expressed some doubt about it, and said they would have allowed us an appeal if it had been possible.

Mr. GARRETT: It is a case which would come under the heading of "Criminal Appeal." I shall impose a penalty of 40s., with 10 guineas costs.

Mr. COOPER: I do not know whether you can say you will not issue any summons until the Parliamentary Committee have reported.

Mr. GARRETT: If it is issued, I should think it would be desirable to adjourn the matter pending the decision of the Parliamentary Committee.

The Charge for Water for Street-Cleansing Purposes.

At the North London Police Court last Saturday, Mr. Fordham gave his decision in a dispute between the Hackney Vestry and the East London Water Company as to the charge for water for street-cleansing purposes. The Company at present charge 9d. per 1000 gallons, whereas the New River Company, who serve a portion of the district, charge 6d.; and the Vestry applied for a reduction, which the Company refused on the ground of the expense entailed in furnishing the supply. Mr. Fordham decided that 6d. per 1000 gallons would leave the Company a fair and reasonable trading profit; and he made an order that this price should be charged. We shall notice the case more fully in a subsequent issue.

The London Electric Supply Corporation Fined.

At the Greenwich Police Court last Friday, Mr. Kennedy gave judgment in the case in which Mr. Shaddick, of the Dover Castle, Deptford, summoned the London Electric Supply Corporation for failure to supply electrical energy to his premises. The summonses were seven in number. When the case was before the Court on the 24th ult. (*ante*, p. 1135) the default was admitted; the defence being that it was essential that some part of the district of the Corporation should be cut off, because the supply was deficient owing to unavoidable causes, and that Deptford was selected as causing the least public inconvenience. The defence of *force majeure* was raised; but Mr. Kennedy held that it did not apply. His Worship said he was doubtful whether the Corporation allowed sufficient time to overhaul the boilers, especially when they knew of the hardness of the water, and that the boilers would not last many weeks. He did not, however, rest his judgment so much upon this ground as upon their taking Mr. Shaddick as a new customer when they knew that, through the failure of the contractors to supply new boilers, and their inability to overhaul the old ones, it was, to say the least, doubtful whether they could adequately supply Mr. Shaddick with the electric light. The penalty was singularly inadequate; and therefore he must inflict the full one of 40s. in each of the seven cases, with 20 guineas costs in the first case, and 2s. costs in each of the others—making £35 12s. in all.

MISCELLANEOUS NEWS.

IMPERIAL CONTINENTAL GAS ASSOCIATION.

The Half-Yearly General Meeting of this Association was held last Tuesday, at the Cannon Street Hotel—Mr. T. H. G. NEWTON in the chair.

The SECRETARY (Mr. R. W. Wilson) read the notice convening the meeting, and also the following report of the Directors:—

The present half-yearly ordinary general meeting of the proprietors has been convened, in conformity with the Association's Acts of Parliament, for the purpose of receiving a report from the Directors upon the affairs of the Company, and of declaring a dividend for the half year ended the 31st of December last.

The following summary shows the results of the Association's operations during that period: The quantity of gas made in the half year was 4445 million cubic feet; while the quantity made in the corresponding half of 1898 was 4672 millions—a decrease of 227 millions. It should be mentioned, however, that the decrease in the production of gas at Vienna, due to the surrender in November of the supply of gas in the Inner Districts, amounted to 410 millions, and that the returns of the second half of 1898 include 72 millions made during six weeks' working at Amsterdam. The increase in the production of gas at the other stations, excluding Vienna and Amsterdam, amounted to 255 millions; giving an average rate of increase of 7·83 per cent.

The total number of lights on the 31st of December last was 2,160,071. At the close of the corresponding half year, the number of lights, including 629,910 in the Inner Districts of Vienna, was 2,591,097—a net decrease of 431,026. The entire length of mains in use on the 31st of December last was 1650 miles. The length of mains on Dec. 31, 1898, was 1925, but it included 343 miles of mains in the Inner Districts of Vienna, giving a net decrease of 275; 68 miles of new mains having been laid during the past year at the other stations.

The number of consumers on the books of the Association on the 31st of December last was 179,970, as compared with 217,200 on Dec. 31, 1898, or a decrease of only 37,230, notwithstanding the loss of 56,000 consumers in the Inner Districts of Vienna.

The decrease in the sale of gas at Vienna during the past half year, and the fact that the returns of the corresponding half year include six weeks' working at Amsterdam, render difficult any useful comparison of either the financial or the technical statistics. The receipts for gas and the profit for the half year under review were naturally proportionately less.

Although there was an average increase of 8¼d. per ton in the gross cost of coal, the net cost was only 2½d. per ton more than in the second half of 1898—a result chiefly due to the considerable improvement in the value of coke, but also to some extent to the economy in fuel resulting from the improved furnaces recently erected at different stations. A decrease in the revenue from tar was practically counterbalanced by an improvement in the values of sulphate and other products of ammoniacal liquor.

The plant and mains at all the stations were maintained at their usual high state of efficiency.

At Aix-la-Chapelle, the renewal of the condensing and washing plant was completed. At Antwerp, the introduction of incandescent burners for the public lighting has given general satisfaction. On the 31st of December, some 2000 public lamps, out of a total of about 8000, had already been fitted with these burners. The recent reduction in the price of gas has been fully justified by the subsequent increase in the consumption.

At Berlin, the erection of additional inclined retorts and accessory plant at the Gitschinerstrasse works was completed in time to meet the heavy demands of the winter months. The new purifier-house and purifiers at the Schöneberg works were completed and put in action. The buildings devoted to the manufacture of meters at the Gitschinerstrasse works having become inadequate, the Directors decided to erect a new and commodious factory on the Mariendorf site, and a commencement has already been made with the erection of the buildings.

At Brussels, considerable extensions of the tar-distilling plant at Forest became necessary, and were completed during the half year. The adaptation of the new premises recently acquired in the Chaussée d'Ixelles to the purposes of new offices and show-room, workshops, &c., was proceeded with. In the commune of Uccle, the prices of gas were reduced to those supplied in the neighbouring commune of Koekelberg; the Association receiving in return a monopoly of the right to supply electricity. The erection of an electric lighting station at Woluwe St. Pierre was proceeded with. The Directors disposed of a plot of land not required at Forest.

At Flushing, additional purifying plant was required; and the disused purifiers from the Esplanade works, Antwerp, were utilized. At Flushing, also, increased storage capacity was required, and a new three-lift telescopic holder will be erected in the tank of an existing 60-feet two-lift holder.

At Frankfort-on-the-Main, the construction of new offices and workshops at the Obermainstrasse and of a new dwelling-house at the Bockenheim Gas-Works was proceeded with. At Hanover, a contract giving a monopoly of the gas supply for 25 years was concluded with the independent suburban commune of Ahlem. At Vienna, the Municipal Gas-Works were inaugurated on the 2nd of November, and on the 11th of that month the connection of the consumers' meters in the Inner Districts with the municipal system of mains was commenced, and the transfer was finally completed on the 30th of December, on which date 58,400 of the Association's meters had passed into the possession of the Municipality by sale. The manufacture of gas at the Erdberg, Tabor, and Belvedere works was discontinued, and arrangements have been made for clearing the sites.

The Directors have secured a monopoly of the gas supply for thirty years in the communes of Kagran and Lang Enzersdorf, supplied from the works in Floridsdorf—an independent commune on the opposite side of the Danube to that on which Vienna is situated. Some land for which there was no further use at Vienna was disposed of to advantage.

The transfer of the small stations of Essegg and Neutra to a new Hungarian Company, styled the Central Gas and Electricity Company, in return for shares equal to the capital value of these stations, was duly effected on the 31st of December.

The Directors have to report that the £234,200 of 4 per cent. debentures, which became due on the 1st of August last, have been paid off; leaving a charge on the assets of the Association of £473,600 of 3½ per cent. debenture stock, which is redeemable, at the option of the Association, at any time after the 1st of August next, upon giving six months' notice.

The Directors desire, in conclusion, to draw the attention of the proprietors to the accounts for the half year ended the 31st of December last. These have been duly audited, and from them the Directors have, in accordance with the provisions of the Companies' Clauses Consolidation Act, prepared a scheme showing the profit of the Association for the half year, and the portion thereof applicable to the purposes of dividend, which they recommend now to be declared—viz., a dividend of 5 per cent. for the half

year ended the 31st of December last, payable, free of income-tax, on and after Tuesday, the 8th of May.

The Directors who go out of office by rotation are Sir Charles James Jessel, Bart., John Henry Birchenough, Esq., and Sir James Morse Carmichael, Bart. These gentlemen are eligible for re-election, and offer themselves accordingly. The Auditor who goes out of office by rotation is Montagu Somes Pilcher, Esq., who is eligible for re-election, and offers himself accordingly.

The CHAIRMAN, after apologizing for the absence of Mr. Arthur Lucas, one of the Directors, who was abroad, moved that the report be received, adopted, and entered upon the minutes. In doing so, he said: In making a few remarks upon the report, I may well echo a statement contained in it—that it is most difficult to make useful comparisons between the financial and technical statistics of the past half year and those of the corresponding period of last year, because the returns of the corresponding half year include the full workings of Vienna and a portion of those at Amsterdam. But there is one very important matter, in considering which, comparisons can be made quite independently of the shrinkage in the volume of business, which renders so difficult useful comparisons in other directions. I refer to the cost of coal. The report states most correctly that the gross cost of coal increased by 8½d. per ton, and the net cost by 2½d. per ton, as compared with the corresponding half year in 1898; and we may hope that in the current half year the net cost may be even less than in the corresponding half of last year. This may seem paradoxical in the midst of a coal famine which, I may inform you, extends to the Continent. But the explanation is simple; and it is well it should be borne in mind. The coal carbonized in a given half year has been bought, it may be a year in advance, and therefore, in such a case, not at famine prices; while much of the coke produced by that coal may have been sold as fuel in competition with household coal at famine prices. Hence the net cost of coal, being the gross cost less the residuals, may be less at the beginning of a coal famine than before it commenced; while, of course, at the end of it the sales of coke, being in competition with cheapening fuel, retard the beneficial effect of the lower cost of coal to a gas company. This increase in the cost of coal is already recognized as a serious question for gas companies operating in this country; but it is a far more serious question for those operating abroad. In this country, particularly in London, the sliding-scale, though beneficial to the consumer when gas companies are prosperous, throws upon him a large share of the loss resulting from excessive increases in the cost of production of gas—a necessary result of dear coal. Besides, in many towns in England, where there is no sliding-scale, but where the lighting is in the hands of long-established gas companies, the price of gas may be below its maximum, and can be, and is, increased in price in such circumstances by the gas company. But, under the foreign system of contracts and concessions, such arrangements are practically unknown. Under this system, the gas is supplied by the gas company for a certain term of years, usually comparatively short, at a certain fixed price, which is none too high, indeed, when coal is cheap, but which may absorb all profit when coal is dear. The importance to us is seen when I remind you that a rise of 6s. per ton in the net cost of coal is equivalent to our paying £120,000 more for the coal carbonized by the Association in a half year, and consequently in a reduction of profit by this amount. This is no mere theory as to the course and effect of a coal famine. Such a famine in the early seventies, which culminated in 1873 in its effects upon the Association, is duly recorded in our annals, and is within my personal experience as a Director; and we will hope that this famine will not be more serious in its effects than that proved to be. Thus we see that gas companies operating abroad have to take all the risks of abnormally high coal prices and consequent loss of profit; but I may remind you that our Association has to a considerable extent ensured itself against such losses by the institution of the dividend equalization fund, which amounts to nearly a year's dividend at the rate of 10 per cent. Reviewing the stations in order, at Berlin, since the close of the half year, a supplementary gas contract and an electric lighting contract have been concluded with the suburban commune of Gross-Lichterfelde. At Brussels, since the close of the half year, the Association has acquired a controlling interest in the undertaking of the Ixelles Electric Light Company. At Vienna, the report states, the Inner Districts ceased to be a profit-bearing portion of the undertaking in November last. At the end of the half year, as the circumstances were exceptional—the loss at Vienna being no longer contingent, but real and palpable—the Directors decided to take an exceptional but a truly businesslike course, and consider the value of the works and business left to us for some years to come at this station; and as this value was found to be considerably less than the corresponding figures in the books of the Association, it was resolved to correct it, and write down the book value to this value. In doing this, a sum was utilized which in the ordinary course would have been absorbed in the contingency fund. The proprietors must not forget that with the loss of Vienna, although there is an enormous decrease in the gross returns which have been derived therefrom in times past, the net effect will not, I hope, be so much felt, because the heavy charges in the nature of amortization, which the station has had to bear in recent years, will now cease. The Board have granted suitable gratuities and pensions to members of the salaried staff and workmen no longer required at Vienna, but who had moral claims on the Association. And in this connection, I may mention that Mr. Lindon, to whom I alluded in eulogy at our last meeting, retired from the service of the Association with an adequate pension as from the 1st of January last. He is, I am sorry to say, in bad health, to improve which he is now travelling abroad. Since the close of the half year, more land no longer required at Vienna has been sold. And now I am sorry to tell you that a well-intentioned effort on the part of the Association to benefit the city of Vienna, and to save its inhabitants from a recurrence of the chaos which reigned when the city mains were being laid, has not met with the success which it deserved. As you are aware, we have an immense length of mains (343 miles) under the soil of the Inner City of Vienna; and, having ascertained, by careful computation, the very lowest net value which the Association could get for these if it took them up, the Board offered them to the City at a still lower sum. According to a telegram received to-day from Dr. Teltscher, the Town Council have rejected the Association's proposal, and we must now proceed to realize the utmost value we possibly can for this asset. The great change we have experienced at Vienna points out that, although this may not be a time for making comparisons with the past in many ways, it is nevertheless very opportune for us to put our house, so to speak, in order, and to consider our present position. To this end, the million odd sterling which we own in English, Indian, and Colonial securities has been written down to the market value of such securities as on the 31st of December last; and I can assure the proprietors that the various items which represent the other capital assets of the Association are at least of their face value. This includes nearly £900,000 invested in the shares of other gas and electric lighting companies, forming to this extent, in the spreading of risks over a large area, what might be called a Gas and Electric Trust. In the result as to capital, after making due allowance for what we owe our debenture stock holders and our various creditors, I find that a net sum of capital assets remains, representing not only the £3,800,000 capital stock of the Association, but also a premium upon it of more than 70 per cent. in tangible securities—a position few companies in the City of London can claim. As to income, I do not fear that six months hence we shall have to dip appreciably into the dividend equalization fund for a 10 per cent. dividend. Later, as I have pointed out, dearer coal may for a time require this. But with the coal famine over, the stations left to us ought, without strain, to provide a 10 per cent. dividend; and we must not forget that we possess a large sum of liquid assets bearing a low rate of interest, which, when opportunity offers for their re-investment, can be made to produce for the proprietors of this Association in the future a far larger return than they do at present.

Mr. JOHN HORSLEY PALMER seconded the motion, and it was carried unanimously.

It was next unanimously resolved, on the motion of the CHAIRMAN, seconded by Mr. CLARENCE PIGOU—"That a dividend of 5 per cent. for the half year ended the 31st of December last be declared on the £3,800,000 stock of the Association, and that the same be payable, free of income-tax, on and after Tuesday, the 8th inst."

The retiring Directors (Sir Charles Jessel, Bart, Mr. J. H. Birchenough, and Sir James Carmichael, Bart.) and Auditor (Mr. Montagu Somes Pilcher) having been re-elected,

Cordial votes of thanks were passed to the Directors, for their able management of the affairs of the Association; to the Chairman, for his conduct in the chair; and to the staff at home and abroad.

The proceedings then terminated.

BUENOS AYRES (NEW) GAS COMPANY, LIMITED.

The Annual Meeting of this Company was held yesterday week, at the London Offices, No. 1, East India Avenue, E.C.—Mr. F. J. HESELTINE in the chair.

The report and accounts (which were noticed in the "JOURNAL" for the 24th ult.), having been taken as read,

The CHAIRMAN opened his address with a sympathetic reference to the enforced retirement of Sir Wilford Brett from the chairmanship, and expressed the keen regret of all connected with the Company. Turning to the accounts, he said it was proposed to add £15,000 to the reserve fund; bringing it up to £40,000. In the accounts for 1898, they added £14,488 to previous reserves; making £20,000, which sum stood at the credit of a special reserve account against discount and expenses of issue of debenture stock and contingencies. After careful consideration, the Board had decided not to act in the drastic manner at first proposed; but to extinguish the discount and expenses account by spreading the amount over a series of ten years. This was a liberal arrangement, seeing that the new debenture stock had 28 years to run. To make clear the benefit derived by the issue of this stock and the cancelment of the 6 per cent. debentures, he said the 6 per cent. debentures fell due, and were extinguished, at the end of 1897; and the annual interest thereon amounted to £12,000. The present 4 per cent. debenture stock amounted to £8800; thus relieving the revenue account to the extent of £3200 annually. As this 4 per cent. stock was not repayable for 28 years, the total saving to the shareholders was £70,694, after paying off the whole of the expenses connected with the issue. On the creditor side of the balance-sheet, £7476 had been added to the value of the property by extensions and additions; and the greater part of this was for inclined retorts. The sum of £6000 had been written off the year's revenue for depreciation of services and meters; £1946 for new plant; and £1890 for discount and expenses *re* issue of debenture stock. With £569 transferred to the reserve fund, these items together amounted to £10,406; and made up the reserve to £40,000. Sundry debtors, which stood at £26,108 in 1898, had been reduced to £18,037. Their relations with the Municipality were most cordial; while the small amount of their indebtedness to the Company showed how punctually they met their financial engagements with them. In connection with the South Barracas Gas-Works, it would be observed that £21,749 had been spent on the Lomas extension. The profits already derived from the South Barracas works were not only sufficient to meet the guaranteed dividend on that Company's shares, and the interest on the debentures held by this Company against the advances made for the Lomas extension, but a substantial balance was left. The whole of the outlay of £21,000 on the Lomas extension was made out of revenue, and had been secured by the issue of debenture stock. Given time to develop, they looked to this extension being a valuable addition to their business. Up to the present, by an expenditure of 40 per cent., they had gained an increase of 70 per cent. in lighting. Following the policy of endeavouring to keep pace with such improvements in manufacture as would enable the Company to give the most economical and efficient supply of gas, the Directors entered into a contract with Messrs. Dempster, of Manchester, for the erection of several benches of inclined retorts and a retort-house. These were near completion, and would be ready for use about June—the commencement of the Argentine winter. With other improvements, they had already reduced wages considerably, and the inclined retorts would reduce them still more. Another advantage was that the price of cannel had lately fallen; and oil having materially advanced, they had nearly arrived at a period when it would not pay to use oil for enrichment. Referring to the use of electricity, he said people were found to be returning to gas, especially as the incandescent mantle had become much cheaper. The Company had, therefore, set themselves to show what gas could do; and a number of street-lamps of the Berlin pattern had been put up, and were,

according to the Manager's report, a complete success. It was therefore expected that, when the new municipal tender was called for, a large number of these lamps would be required. The past year had been an exceedingly trying one to the management of gas undertakings, owing to the rapid and abnormal advance in the price of coal, oil, and other articles. In their own case, they had to face a considerable depreciation in the value of the currency in which they received payment for their gas and products; and the increase in taxation had brought the item up to £15,000. The Custom House had affected the industry in regard to the imported articles used—excepting coal and naphtha—such as glass, galvanized iron, tools, and meters, all of which had had an increase of 25 per cent. placed on them, in addition to the rise in price on this side. Notwithstanding all these adverse circumstances, it was satisfactory to be able to tell the shareholders that, by the economies introduced, they had manufactured gas at 2d. per 1000 cubic feet less than in 1898. The Directors had satisfaction in reporting that they had entered into contracts for the whole of their coal for the present year's working at a slightly lower figure than that of last year—that was, taking the coal and freight together. Products, unfortunately, were a drug; and £5700 less than in 1898 was received for them. This was due in great measure to the price of coke, which fell heavily in March on account of the keen competition with the imported article. They had since been able to advance rates considerably owing to the high price of coal, which had driven their competitor out of the field. He ventured to think the shareholders would not consider the result of the year's trading unfavourable, as it enabled the Directors to recommend the payment of a dividend of 6 per cent., and after payment of all fixed charges, and making provision for bad and doubtful debts, to carry forward £3224. Concerning the keen competition that took place in Buenos Ayres between the Companies interested in supplying gas, he said that for some time past, the Board had, through their representatives, shown the folly and reckless waste of money to all concerned in this competition, and had pointed out the advantages to be derived by coming to a districting arrangement. This matter fell more particularly within the province of the Local Committee and the Manager (Mr. Obarrio). It was very gratifying to the Board to find how energetically and zealously their opinions had been supported; and by an interchange of views with the other Companies, they had, the Board believed, brought them to their way of thinking. He concluded by proposing the adoption of the report and the declaration of a dividend at the rate of 6 per cent., 2½ per cent. of which has already been distributed.

Mr. J. C. Im Thurn seconded the motion.

Mr. S. Spencer remarked that the balance-sheet was the best they had had during his connection with the Company. It was particularly pleasant to hear that on the question of a working arrangement among the Companies, they were arriving at harmonious views. If they had got to that point, their prospects must be considerably improved.

The motion was unanimously adopted.

The retiring Directors, Mr. R. Nesham and Mr. F. C. Im Thurn (the latter of whom succeeds Sir Wilford Brett on the Board) were re-elected.

The Auditors having been re-appointed, the usual complimentary votes were passed. A resolution was also passed recording the shareholders' deep regret at the retirement of Sir Wilford Brett from the chairmanship—a post which he had occupied since the establishment of the Company.

SOUTHAMPTON GAS COMPANY.

The Half-Yearly General Meeting of this Company was held last Wednesday—Mr. R. C. Hankinson, J.P., in the chair.

The Secretary (Mr. C. Crowther Smith) having read the notice convening the meeting, the report of the Directors was presented. It set forth that during the six months ending Dec. 31 last there was an extra sale of 14,942,000 cubic feet of gas, as compared with the corresponding half of 1898; while for the entire year 1899, the increase was 24,712,000 cubic feet—the maximum yet attained by the Company. This has necessitated the provision of more storage; and plans have been approved for the construction of a holder to contain 2 million cubic feet of gas, which will double the present storage. The profit and loss account showed that the amount available for distribution was £10,710; and the Directors recommended the payment of maximum dividends, amounting to £9006, for the half year on the ordinary stock, less income-tax. This would leave £1704 to be carried forward. An intimation was given that the shareholders would be asked to sanction the raising of further capital for the general purposes of the undertaking, including the development of the prepayment meter system. Reference was made to the coal question, and the Directors stated that in consequence of the enhanced price the charge for gas would inevitably have to be considerably increased.

The Chairman, in moving the adoption of the report, said the first item to be noticed was the augmented sale of gas in the past half year, which represented something like £2600 money value, and the increase for the year represented 5·78 per cent. over the preceding twelve months. A continually growing business like theirs required, of course, extra expenditure; and this was the reason why the Directors were from time to time obliged to raise fresh capital. They had to look to it that the provision for the storage of gas was in right proportion to the business they had to do. But theirs was not what it ought to be, and the Directors had taken steps to provide a new holder, which would double the capacity. This was absolutely necessary; but at the same time it was a very expensive matter. With regard to the profit and loss account, the shareholders would remember that for some time, until the past half year, the Company had not been able to earn their maximum dividends. They had now been able to do so, and carry forward rather more than £1700. The coal supply had been a very anxious subject with the Directors—he did not mean as regards price, because they had a good contract, which would not come to an end till the 30th of June—but the difficulty of getting the coal delivered. The contractors had done their very best; but it was with some difficulty that they had fulfilled their contract. It was still a rather anxious time—the price of coals having gone up to such an extent; and he ought to add a word of warning—that although the Company had had a satisfactory half year, and though the current one was likely to be equally so, the Directors, in consequence of the increased cost of coal, would have to raise the charge for gas. They were unwilling to do this; but such a course was inevitable. Another item of interest was that there had been 308 new consumers added to their ordinary customers, not taking into account the prepayment meter supplies. There were, in addition, upwards of 1500 consumers on the latter system, nearly all of whom used gas cooking-stoves; and there were also a large number of applicants waiting to be supplied. Gas-fires and heating-stoves continued to be very popular, and there were something like 3000 cooking-stoves now in use in the town. The Directors always had it in their mind to keep the works in the highest state of efficiency. They spared no pains and no money to attain this end, for they believed it to be the most economical policy to adopt.

Dr. Sampson seconded the motion; and it was carried.

The payment of the maximum dividends having been authorized,

A special meeting was held at which the raising of further capital to the amount of £50,000 of ordinary 5 per cent. stock and £20,000 of 4 per cent. debenture stock was formally sanctioned.

The proceedings closed with the usual complimentary votes to the Chairman and Directors, Secretary, Auditors, and staff, for their services during the half year.

THE PROPOSED ROYAL COMMISSION ON COAL.

Unworked Stores of the Mineral.

The proposal put forward by Mr. Provand, M.P., for the appointment of a Royal Commission to inquire into the probable duration of the British coalfields and the disposal of the coal (see *ante*, p. 881), has resulted in some interesting correspondence in the "Iron and Coal Trades Review." Sir Alfred Hickman, of Wolverhampton, says that the result of his observation is that new and hitherto unknown seams of coal are being discovered quite as fast as the old ones are exhausted. The deposit recently found at Penkridge, in his opinion, includes practically the whole of Central Staffordshire in the coalfields; and it has been proved that the Warwickshire deposits are much more extensive than actual demonstration has hitherto shown them to be. An authority on this subject—Mr. A. L. Steavenson, of Durham, a former President of the Northern Institution of Mining Engineers, who has been working coal for about half a-century—states that in one field upon which he has lately had his eyes there is, he believes, as much untouched coal as would provide for a continuance of the present output of 220 million tons per annum for the next 250 years. Another writer—Mr. G. W. Walker, of the Wharncliffe Silkstone Collieries—considers it has been proved that the Yorkshire seams extend to the Trent, and also eastward throughout a large area of Lincolnshire. A less optimistic view is taken by Mr. J. A. Longden, of the Stanton Iron-Works Company, Nottingham, who reiterates an opinion expressed nearly twelve months ago, that the cheaply-worked coal of this country will be exhausted in fifty years. He considers that the enhanced cost of mining, owing to increased wages, shorter hours, thinner seams, deeper mines, &c., will in all probability be permanent. One of the latest writers on the subject is Mr. W. H. Chambers, whose letter is as follows: "I do not see that any useful purpose would be served by the inquiry. Mr. Provand alludes to the very erroneous conclusions arrived at by a similar Committee whose report was founded upon investigations made in the years 1866 to 1871. To show the value of these inquiries, there is at present more coal available for working than the Commission believed to exist at the time their report was made, which is proved by borings and sinkings over the last twenty years. Taking the Yorkshire coalfield as an example, the continuation of the coal seams at a workable depth has been proved by the borings to extend to some 12 miles east of any colliery now working in the district. This shows, as I mentioned last June at the meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers, of which I am President, the existence of an area of coal, in addition to that available to present collieries, which will produce upwards of 10,000,000 million tons, capable of maintaining the present output of Yorkshire for more than 400 years. It is, however, well known that coalfields lie in basins, and these borings are probably near the bottom of the basin. This must be so unless the coal suddenly ceases in the centre of the earth, which has never been known in the history of mining; so that, unless Nature has departed from her hitherto invariable course, there must necessarily be some 40 to 50 miles of coal seams rising to the east, in addition to the area absolutely proved upon which I have based my calculations. An export duty on coal would certainly result, in ordinary times, in the closing of many collieries, and the locking up of our resources of mineral wealth and general prosperity. Miners would be thrown out of work, and would necessarily emigrate to new coalfields in foreign countries, which are even now being only too quickly opened up to meet the world's demands. If England must eventually become an agricultural country, why should it be necessary to precipitate that condition? There always were, and always will be, some people who would reduce the nation to the condition of mind which caused the wealthy miser to starve himself to death for fear he might die in the workhouse."

Gas Profits at Rochdale.—The returns presented to the Gas Committee of the Rochdale Corporation for the year 1899-1900 show that the gas-works, which are under the supervision of Mr. T. Banbury Ball, will furnish a sum to be handed over for the relief of the rates which is the largest on record. The receipts for gas, residuals, &c., amount to £83,272, against £70,883 for the preceding year, showing an increase of £12,389. Of the profits, it is proposed to place £13,000 for the relief of the rates, and to put £3000 to the reserve fund. The former amount is £4016 in excess of that of last year, and but for this increase in profits the rates, would have had to be materially increased. A rate of 1d. in the pound at Rochdale realizes about £1000; so that the gas profits are equal to more than a 1s. rate. The receipts from gas are nearly £30,000 in excess of what they were a decade ago; and during the last ten years no less than £87,531 from the gas profits has gone to the relief of rates, and £25,500 to the reserve fund—making a total of £113,031.

THE EXAMINATIONS IN GAS MANUFACTURE.

The Question Papers at the City and Guilds of London Institute Examinations.

The examinations in "Gas Manufacture" conducted by the City and Guilds of London Institute were held last Wednesday. The following were the questions set by the Examiner, Mr. Alfred Colson, M.Inst.C.E.

ORDINARY GRADE.

1. Give a sketch showing the construction of a bed of six retorts, heated by direct fire. 2. What is the effect of condensation on the hot crude coal gas, and how are the results affected by the rate of cooling? 3. Give a short account of the liquid products obtained by the distillation of coal. 4. Explain the construction of the tower scrubber. How would you test the gas at the outlet to ascertain if it was free from ammonia; and, if not, how would you determine the amount passing? 5. What is the use of syphons in connection with the manufacturing plant? Show, by means of diagrams, the level of the liquid in a syphon (*a*) when the pressure of the gas is less than that of the atmosphere, and (*b*) when it is greater. 6. Describe the method adopted for the removal of sulphuretted hydrogen and carbonic acid from crude coal gas. 7. What advantages are gained by the use of an exhauster? 8. Give a sketch showing the construction of a consumer's wet gas-meter. What precautions are adopted to maintain its accuracy? 9. Show by means of a sketch the construction of any form of governor burner. What is the advantage of such burners? 10. What is the meaning of the term "corrected for temperature and atmospheric pressure;" and what are the principles according to which the correction is made?

HONOURS GRADE.

1. Describe, with the aid of diagrams, the construction of a regenerative furnace for heating a bed of gas-retorts. What should be the approximate composition of the producer and waste gases, and how may this be regulated? 2. Explain the objects of the hydraulic main, and give a sketch of this apparatus, showing the method of removing the tar and liquor which separate in it. 3. What is the effect of varying retort temperatures on the composition of the products of distillation? 4. At what points, and by what means, is the removal effected of the ammonia contained in the crude gas issuing from the retorts? What other impurities are simultaneously removed, wholly or in part? 5. Give a sketch showing the construction of any one form of rotary washer-scrubber. What are the comparative advantages and disadvantages of such apparatus and the tower scrubber? 6. Give an account of the method adopted for the removal of carbon bisulphide from coal gas, and of the necessary precautions to ensure a fairly complete elimination of this impurity. 7. Explain, with the aid of sketches, the construction of a trussed and untrussed gasholder crown, and also of any one form of gasholder without columns. 8. Give a description of the method of manufacturing carburetted water gas (exclusive of condensation and purification). What differences exist between the tar obtained from the oil and coal tar? 9. What is meant by "unaccounted-for gas?" State as fully as you can the various items of which this is made up. 10. Give an account of the method of determining the illuminating power of gas (*a*) by the Letheby-Bunsen photometer, and (*b*) by the London Gas Referees' table photometer, with especial reference to differences in the method of testing by means of the two photometers.

In the Ordinary Grade, 40 marks were allowed for Nos. 1, 4, 6, 8, and 10; 35 for No. 2; and 30 for the rest. In the Honours Grade, 40 marks were allowed for Nos. 1, 4, 5, 6, 7, and 8; 35 for Nos. 3 and 10; and 30 for Nos. 2 and 9. Only eight questions were to be answered in either grade.

The Polytechnic Examinations.

As our readers are aware, the class for "Gas Manufacture" at the Polytechnic Institution is conducted by Mr. W. Grafton, F.I.C., F.C.S. (of Beckton). The examinations took place on the 25th of March; and the results were made known last Tuesday. The following were the questions set by the Examiner.

ORDINARY GRADE.

1. Give a sketch of the Referees' test for sulphur, and explain its use. 2. Give a detailed description of the process called "Condensation." 3. How would you purify gas from CO_2 and SH_2 simultaneously? 4. Describe fully, with sketch, the hydraulic main and dip-pipe. 5. How and where would you detect CO_2, SH_2, CS_2, and NH_3 on a gas-works? 6. Give a sketch of the "open" joint for gas-mains, and state why syphons have to be used. 7. Wherein lies the difference between a bunsen and a luminous burner? State the nature of the products resulting from the combustion of gas by each. 8. Describe a pressure and an exhaust register, and state what is the use of them. 9. By what method would you ascertain the illuminating power of coal gas? 10. How would you test ammoniacal liquor for ammonia?

HONOURS GRADE.

1. Describe some form of carburetted water-gas plant. 2. How would you effect complete purification of coal gas, having regard to economical results? 3. Describe the scrubbing plant used on a gas-works; and give a part sectional sketch of the one you think best. 4. Describe, and illustrate by sketches, a setting of inclined retorts, stating the advantage over the horizontal type. 5. How would you determine the percentage of CO in a sample mixture of carburetted water gas and coal gas; and what amount of this impurity would you expect to find? 6. What are the constituents of purified coal gas and carburetted water gas? Indicate the relative proportions in which these constituents are present in each, and show where the difference exists between the two gases. 7. Describe the principal gas-burners in use. Draw a comparison between each. 8. Describe, with outline sketch, a setting of eight retorts and fittings on the generator system. 9. Describe the Referees' new method of ascertaining the illuminating power of gas. 10. Give some account of three principal kinds of coal, and the quantity of gas, tar, &c., produced per ton from any one.

The following are the names of the successful candidates: Honours Grade—Mr. D. J. Winslow (silver medal), Mr. W. J. Johns (certificate and books of the value of 10s.), Mr. P. F. Scarth (certificate and books of the value of 5s.), Mr. A. F. Ball, and Mr. A. Mead. Ordinary Grade—Mr. Whyte (bronze medal), Mr. Eldred (certificate and 10s. in books), Mr. Holland (certificate and 5s. in books), and Mr. Mead, junr. Mr. Winslow headed the list in the Honours Grade with 88 per cent. of marks; Mr. Johns following him closely with 86 per cent.; and Mr. Scarth taking 68 per cent. In the Ordinary Grade, the bronze medallist secured 85 per cent. of marks; the other prize winners running each other close with 80 and 79 per cent. respectively.

MANCHESTER CORPORATION GAS, ELECTRICITY, AND WATER SUPPLY.

The Estimates for the Ensuing Year.

At the Meeting of the Manchester City Council last Wednesday, the estimates for the ensuing year, prepared by the various Departmental Committees, were brought up for consideration. The Chairman of the Finance Committee (Alderman King) submitted the financial reports and estimates of the several Committees, other than the Water Committee, with the comments of his own Committee thereon.

Gas Committee.—The profit and loss account of this Committee showed a total income of £643,341 for the year ending March 31 last, against an estimate of £612,000; the actual and estimated receipts being as follows: Gas-rents, actual £512,437, estimate £510,000; coke, actual £64,470, estimate £51,000; tar, actual £34,497, estimate £25,500; ammoniacal liquor, actual £31,140, estimate £25,000; sundries, actual £797, estimate £500. The expenditure for the year was £581,191; leaving a surplus of £62,150, as compared with an estimate of £560,000 expenditure and £52,000 surplus. The principal items of expenditure were: Cannel, coal, and oil, actual £253,294, estimate £250,000; carbonization (retort men's wages, &c.), actual £56,808, estimate £51,500; retorts, actual £13,138, estimate £13,500; purification (less sales of spent material), actual £9176, estimate £9000; repair and maintenance of works and mains, &c., actual £67,019, estimate £63,000; renewals of plant, actual £27,492, estimate £23,500; salaries and wages of clerks and inspectors, actual £34,110, estimate £34,000; rates and sundry taxes, actual £27,235, estimate £27,000; interest on loans, &c., actual £37,980, estimate £38,007; sinking fund (for liquidation of debt), actual £36,686, estimate £36,642. The estimated income for the year ending March 31, 1901, is as follows: Gas-rents (including £33,500 for city lamps), £520,000; coke, £65,000; tar, £35,000; ammoniacal liquor, £32,000; sundries, £1000—total, £653,000. The estimated expenditure is £643,100; the principal items being as follows: Cannel, coal, and oil, £300,000; carbonization, £60,000; retorts, £14,000; purification, £10,000; repair and maintenance of works and mains, &c., £68,000; renewals of plant, £25,000; salaries and wages of clerks and inspectors, £36,000; rates and sundry taxes, £38,200; interest on loans, &c., £38,028; sinking fund (for liquidation of debt), £37,421. The estimated surplus is £9900, which, added to the amount transferred from the profits for the past financial year (£10,100), would make a total of £20,000 payable to the city fund in aid of the rates. The estimated expenditure on capital account for the ensuing year is £123,510; the principal items being £44,612 at the Bradford Road station, £12,930 at the Poland Street stores, £15,000 for street mains, £20,000 for hired meters, and £15,000 for hired stoves. The amount spent last year was £72,972, on an estimate of £91,800. The estimated expenditure for street lighting is £46,908, to be raised out of the city rates, which means an average rate of 3·78d. in the pound. This represents an increase of £1790 on the amount paid during the past year.

Electricity Department.—The department anticipates an income of £100,300; the principal item being £99,800 for sales of current (including £2000 receivable from the city fund for street lighting). The income for the year ending the 31st of March last was £85,589. The estimated expenditure for the current year is £100,300, including coals, £18,160; wages, £8260; repairs and maintenance of buildings, machinery, mains, &c., renewals of plant account—amount transferred, £11,000; interest on mortgage debt, &c., £21,600; sinking fund, £18,280. The expenditure during the past year was £77,589. The Committee do not anticipate being able to pay anything to the city fund. Last year they handed over £10,000 towards the relief of the rates. The estimate for capital expenditure is £310,018; including £116,568 for mains, and £175,000 for buildings, machinery, &c.

Alderman KING, in commenting on the estimates, said the chief increases were in the Gas and Electricity Departments. The Gas Committee expected to be able to pay only £10,000 instead of £52,000 in aid of the rates; the principal reason for this being the extra cost of cannel, coal, and oil, without a corresponding increase in the revenue. On the electricity account, it was estimated that the profit for the year would be absorbed in payment of the interest and sinking-fund charges, in capital outlay for new buildings and machinery, and in laying mains in the city and adjoining districts; so that the Committee would have nothing to hand over in aid of the rates.

It was agreed to postpone the consideration of the estimates to a special meeting of the Council; and a suggestion was made that the Committees might, in the meantime, reconsider their estimates, with a view of relieving the city rates. In the course of an informal discussion, however,

Sir BOSDIN LEECH observed that, as the Gas Committee would not be able to contribute anything like the usual amount towards the relief of the rates, perhaps the question of raising the price of gas might be considered.

Alderman RUSHWORTH remarked that there was a growing feeling in the direction indicated.

Alderman GRIFFIN said he did not see much prospect of the Gas Committee keeping the expenditure down. The price of coal had gone up considerably—not less than 4s. or 5s. per ton; and there was little prospect that they would be able to do anything to relieve the rates.

The LORD MAYOR (Right Hon. Thomas Briggs), the Deputy-Chairman of the Gas Committee, said if they advanced the price of gas 3d. per 1000 cubic feet from the 24th of June next, it would mean £42,000 extra for the year ending March, 1901; and of this amount the out-townships would pay £7100. If the price were raised 3d. per 1000 cubic feet early

in September, the extra receipts would be £33,000, including £5700 from the out-townships. If they were compelled to buy coal to carry them on from the 31st of March this year to the corresponding date in 1901, it would cost about £120,000; but they had nine months' consumption already purchased, and only three months' supply to buy, which would cost them about £30,000. If they did not advance the price of gas 3d. this year, they would have to raise it 6d. or 7d. next, because there was no probability of any reduction taking place in the price of coal.

Mr. SUTTON reminded the Council that, although the price of coal had gone up 50 per cent., the men who "got" the coal only received 15 per cent. increase in their wages.

Water Committee.—The profit and loss account for the year ending March 31, 1900, showed a deficiency of £3199; but there was a surplus from the previous year of £44,976—making a net surplus of £41,777. The estimated income for the year is £329,577, including £47,000 to be raised by the domestic and public rates; and the estimated excess of expenditure over income is £3328. Deducting this from the previous surplus, the balance will be £38,449.

On the motion of Sir JOHN HARWOOD, the Committee's reports, estimates, and accounts were adopted; and it was agreed to levy a domestic water-rate of 8d., and a public water-rate of 1d. in the pound, upon all property assessable thereto, for the year ending April 1, 1901.

The presentation of the minutes of the Electricity Committee gave rise to a discussion, in the course of which

Mr. HAMPSON asked why it was the consumers had so small a supply of electricity in the north and north-east districts. While the main had been laid as far as Didsbury in the one direction, it had not been laid along Cheetham Hill Road. In that district, there were many works which could do with an electric supply. It was a scandal that the mains should be placed in localities outside the city, where they were yielding no revenue, while remunerative districts in the city were neglected. It was painful to him, as a business man, that this great undertaking, which cost between £300,000 and £400,000, should be down in the estimates as returning no revenue. If a private concern had been worked on the same principles, it would have been in the Bankruptcy Court. The street explosions which had been going on for some time showed that the mains were a permanent source of danger in Manchester. He was of opinion that they were more or less using the funds of the Corporation for teaching and giving information which ought to have been gathered by people in a responsible position before they came there.

Alderman RICHARDS also criticized the Committee, and said it would be advisable to have a return of what they would probably get from the out-districts to which they were supplying electricity.

Mr. WILSON referred to the frequent breaking up of the streets for the purpose of laying mains.

Sir JOHN HARWOOD said he was Chairman of the Electricity Committee when the cables which had proved defective were put down. They were laid on the best expert advice available; and the Committee were not to blame if knowledge which was not then to be obtained had since come to light.

Alderman HIGGINBOTTOM, Chairman of the Committee, said the main had not been laid in Cheetham Hill Road because the existing plant would not have given the requisite voltage. He would remind those who criticized the Committee that they had, since 1893, handed over £68,000 to the city fund, and had built up a reserve of £40,000. The cables were laid under the best advice obtainable. It had been found, however, that the climate of Manchester would not allow the Silvertown cable to "live" there. This had happened in other places where that cable had been used. It was only these cables which had proved defective; and he did not think they would have any trouble from those by which they had been replaced. These were of a type specially made to prevent ill-effects from moisture or other outside influences. They were not worse off in Manchester than in other parts of the country; and he did not think the Committee should be condemned because of the explosions. As to the policy of going to outside districts and taking over their local Orders, this matter had been fully explained to the Council when they gave the Committee power to adopt it. They acted on the broad principle of extending the electric light service, and ultimately working the whole of the tramways in the outside districts in connection with the electric lighting. It was a right policy, and would repay the city a hundredfold within a very few years. They would never have heard any complaints had it not been for the fact that they did not expect to be able to pay £10,000 or £12,000 to the city fund this year. They could pay it if they wanted to; but they did not wish to do it on a false basis. Coal had risen 50 per cent. They had made good contracts; but these had run out, and instead of 8s. 6d., they would have to pay 14s. 6d. per ton. This had made a difference of over £6000 in the estimated revenue. The other was due to the sinking fund, and interest on expenditure for mains laid in the city and some parts of the outside area. These had not yet resulted in any adequate return; but he would undertake to say there were some parts of the outside districts which would in time give them a much better return than some parts of the city itself. If the new mains did not within the next few years repay them for their expenditure, the Committee would say they had made a mistake, and ask the Council to increase the price of the current because it was cut down below the remunerative limit.

The minutes were approved.

STALYBRIDGE CORPORATION GAS SUPPLY.

Mr. Carr's Salary Increased.

At the Meeting of the Stalybridge Town Council last Tuesday, a resolution of the Gas Committee that the salary of the Engineer and Manager (Mr. William Carr) should be increased by £100 per annum came up for confirmation. The adoption of the Committee's minutes having been moved and seconded, Mr. Hopwood commented upon the absence of the Chairman and Deputy-Chairman of the Committee, because he thought they should have told the Council, in the presence of the representatives of the Press (so that it would get to the ratepayers, who found the money) something about the abilities that Mr. Carr possessed, and to show that the advance was really a proper thing to make, which he personally fully believed, and which they could, he thought, satisfactorily explain. He supported the proposal in Committee on the strength of what the Chairman and the Deputy-Chairman said; and if he were entitled to the information in Committee, the ratepayers were entitled to it. But not a word was said about it; and he had heard an abundance of complaints outside—not that Mr. Carr was not worth £500 a year, or that he had not splendid abilities, but that Stalybridge was not big enough to pay such a salary. Alderman Ridyard thought he might make a few remarks on the subject. Mr. Carr was appointed as Engineer and Manager to the Gas Committee. When new works were carried out during the time of Mr. Loam, he had an allowance, over and above his salary, for any work he did as Engineer. Mr. Carr had carried out very extensive and very profitable works, for which he had had no allowance whatever. If these works had been undertaken by an Engineer, he would have required an allowance which would have come to more than four years' payment of the advance to Mr. Carr. A Manager was not like an ordinary workman. There was no limit to the sphere of a Manager. His control extended over all the items of the establishment, both human and mechanical; and the consequence was that a man of exceptional ability was worth an exceptional salary. But the benefits Mr. Carr had achieved warranted them, in his (the speaker's) opinion, in paying such salary. When Mr. Carr came to Stalybridge, the price of gas was 2s. 10d. per 1000 cubic feet; and now, under circumstances which were infinitely worse, the price had been reduced to 2s. 3d. They might not know it already, but this was an actual present to the ratepayers of Stalybridge of £4500 a year. He thought they could afford to pay an advance of from £300 (the late Manager's salary) to £500 when they were getting such a present. In addition to this, Mr. Carr had done a great deal at the gas-works which had been put to the revenue account; but if it had been placed to the capital account, the profits would have been considerably larger than they were. He regarded it—and he would emphasize the point—that the salary of £500 a year was exceptional; and he voted for it because he considered that Mr. Carr had secured exceptional benefits for Stalybridge, and that he deserved such a salary on account of his special abilities. Mr. Sidebottom, referring to a remark which had fallen from Alderman Ridyard, said that while there was no limit to what a good man could do, it should have been added that there was no limit to what a bad one might do. The minutes were passed.

LINCOLN CORPORATION GAS AND WATER SUPPLY.

The Annual Reports.

At the Meeting of the Lincoln Town Council last Tuesday, the annual financial statements of the Gas and Water Committees were submitted.

Mr. WALLIS laid before the members the figures referring to the Gas Department. He said that the expenditure had been £33,893, as against £27,580 in the previous year. Coal had cost them £17,985, as compared with £15,130. Repairs, maintenance of plant, renewals, &c., required £2632, as against £2881. Repairs, maintenance, and renewal of mains and service-pipes, &c., proved the most important matter in the whole report. Last year in this direction £3665 was spent; while in the preceding year the figure was only about £700. This was chiefly for new mains, which had cost some £2900. On the receipt side, he found gas produced £26,617, as against £25,617 in 1898-9—about £1000 more. But for part of the year the gas charges were reduced from 2s. 3d. to 2s. 1d., which made a difference to the account of about £800. Thus, if they had maintained the same rate all the year, the receipts would have been some £1800 more than the previous twelve months. The sales of coke, tar, and sulphate of ammonia showed that the receipts had increased considerably—something like £3000. Coke alone showed an increase of £2000, and sulphate of ammonia £500 or so more. The total receipts were £41,755, as against £37,684. Thus £7851 was carried over to the profit and loss account, in comparison with £10,103. The year had been quite as profitable; but they had had to pay so much more for coal, and had had to spend so much in pipes, &c. The gas trading account showed that £8525 had been spent on the usual fixed charges of the department; and the Committee had only the £7851 in hand—leaving a deficiency of £663 for the year, as against a surplus profit in 1898-9 of £1922. The working statistics showed that 2000 tons more coal had been used, and 15 million cubic feet more gas made. The gas sold showed about the same increase—some 14¾ millions. The position of the concern was thus this: The amount of reserve fund was £20,000; and £18,000 had been invested. They required for water-gas plant £13,500; and this at present they had no power to borrow. The Local Government Board had not, in their unwisdom, agreed to allow them to borrow it. As this was a necessary scheme, the Committee decided that, wherever the money came from, they would do the work; and therefore they would have to find it out of the £20,000. The working capital amounted to £9830. In the first instance they were burdened with the whole concern, and nothing to work with. They had, by sticking to business, and by having a good Manager, not only got the £20,000, but £9830 as a floating capital. They also had £2000 out of the £20,000, so that really there remained £11,800 as floating capital. He was very sorry to say they must have £600 out of the floating capital to meet the expenses of the present year. They would in all likelihood have to pay 5s. per ton more for the coal. During the past year, the cost of the coal had been nearly £3000 more than in the previous year; and the year before that it was several hundreds up. This year £7500 would be the total; but they would make certain savings, and were looking forward to securing £1000 more out of coke, tar, &c. Before concluding, he foreshadowed a rise in the price of gas during the year.

The report was adopted.

Dr. COLLIER submitted the report of the Water Committee. Among other particulars, it showed that the number of houses supplied on March 25 last was 11,715; and the quantity of water pumped was equal to an average daily consumption per head of 25·7 gallons. The income had been very satisfactory; the net increase having been £539. The balance in hand was £4803; the profit for the year having been £2315. But this had been ear-marked; new filter beds and engines being required.

The report was adopted, as was also a recommendation that application be made to the Local Government Board for sanction to borrow £16,000 in connection with proposed new works.

STOCKTON GAS-WORKS ACCOUNTS.

At the Meeting of the Stockton Town Council last Tuesday, the Gas Manager (Mr. W. Ford) reported that the total make of gas during the past year had been 386,106,000 cubic feet, or an increase of 25,516,000 feet, which was equivalent to 7 per cent. The unaccounted-for gas had been 4·54 per cent., against 5 per cent. the previous year. The average illuminating power had been 17·10 candles, with no trace of sulphuretted hydrogen; and other sulphur compounds only averaged 11·68 grains per 100 cubic feet, which showed that the purity of the gas supply had been maintained in a favourable manner. There were now 4041 gas-cookers on hire, or an increase of 290. The Accountant (Mr. J. Reay) also presented a statement of the gas revenue account, showing that the profit during the year had been £4610, against £4098 in 1899. It appeared from this that, while the expenditure on coke, coal, oil, and wages had risen from £18,791 to £23,157, there had been large increases in the income from the sale of the gas products—£1600 in the case of coke alone, and £600 in tar. Mr. Meggeson remarked that he was pleased to find there was an increased profit of £500. It showed there was not the justification held out for the recent increase in the price of gas.

WEST BROMWICH CORPORATION GAS SUPPLY.

Probable Increased Charges.

At the Meeting of the West Bromwich Town Council last Wednesday—the Mayor (Mr. S. Pitt) presiding—the Gas Committee reported that the sales of gas during the financial year ending the 31st of March last were 295,874,900 cubic feet; being an increase of 23,602,200 cubic feet over the previous year. The amount of the gas-rental for the same period was £37,545, an increase of £3209. In submitting the report, Mr. Wilson pointed out that in the amount received for gas during the year there was an increase of 8¾ per cent. It might be interesting to the Council to know that at the present time there were 5220 ordinary meters and 4810 prepayment meters in use in the borough. The augmentation in the consumption of gas was due very largely to the extensive adoption of the latter class of meters. He was afraid, however, they could not hope for so large an increase in the future from this source. When they remembered that out of the 13,702 houses in the town only about 4000 of them were at present without a supply of gas, they would see that they had reached about as high as they could. There was a large increase in the quantity of gas consumed for ordinary purposes during the year; while that supplied for motive power had gone up by 24½ per cent. The total increase in the consumption in the borough for the last two years had been 18¼ per cent. Though this was very gratifying to the Committee, they were fully alive to the fact that it also added to their responsibility. They had to make further provision for the future; and at present he confessed they were somewhat in the dark as to what that future would be. Something would certainly have to be done very soon to prevent the town from suffering from any lack of gas. The Committee therefore hoped to come before the Council shortly with a scheme for the extension of the productive capacity of the works. He did not see how it was possible to escape an increase in the charge for gas during the coming twelve months. The price of coal had gone up; and the Committee had accepted contracts at largely increased amounts. They would, however, take care that there should be no increase but that which was absolutely necessary. The report was approved.

ROTHERHAM CORPORATION GAS SUPPLY.

At the Quarterly Meeting of the Rotherham Town Council last Wednesday,

The Mayor (Mr. G. Gummer) made his annual statement on the affairs of the Gas Department. He congratulated the Committee on the successful year's working, considering the difficulties they had had from time to time. At one period of the year they had had the greatest trouble in obtaining supplies of coal; and the coal they did get was not of the quality they had a right to expect. Under the circumstances, he thought the gross profit of £11,545, as against £9829, was very satisfactory. They had had to pay an average price of 11s. per ton for coal, as compared with 9s. 7d. per ton. The working expenses, renewals, and repairs had been abnormally high, and had cost £5095. Then extensions and alterations of mains had cost £2177. Other items of a sundry character had absorbed £1850. These made a total charge to the revenue of £9122. Fortunately, they had a contingency fund; and they had drawn upon it. They had carried to a suspense account £4500; leaving a balance against revenue of £4622. The increased make of gas was 9½ per cent., as against 8¾ per cent. in the previous year; and the increased consumption was 12 per cent. This was accounted for by the decreased leakage; and he thought the Engineer should be complimented upon the manner in which he had tackled this question. The number of coin-meters in use was 5720; being an increase of 574 during the year. The percentage of increased consumption in the coin-meters was 23, as against 10 in the ordinary meters, which numbered 4275. Out of the gross profit of £11,545 they had paid £5140 for dividend on stock and redemption instalments, £300 to sinking fund, £1009 interest on mortgages, £905 in bank interest, and £2154 for public lighting—leaving a surplus of £2034. The capital of the gas-works was £173,283, as against £144,878 last year. In the minutes there was a resolution appointing a Committee to decide as to the increase in the price of gas, and to make further inquiries before fixing the amount. Leeds, Bradford, Hull, Halifax, and Keighley had found the demands of the coal owners so exorbitant—they were anticipating an increase of 5s. per ton in the cost of coal—that they had amalgamated for the purpose, if possible, of doing something to prevent such a great increase. It was even proposed, wisely or unwisely, to start a municipal colliery, with a view of making an attempt to stop these increased charges. Another matter the Committee would have to consider was the restrictions likely

GAS AND WATER COMPANIES' STOCK AND SHARE LIST.

Referred to on p. 1210.

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p. c.	GAS COMPANIES.			£ s. d.
590,000	10	Apl. 11	10½	Alliance & Dublin 10 p. c.	20—21	..	5 0 0
100,000	10	,,	7½	Do. 7 p. c.	13¾—14¼	..	5 3 5
800,000	100	Jan. 2	5	Australian 5 p. c. Deb.	102—104	+2	4 16 2
200,000	5	Nov. 15	6	Bombay, Ltd.	6¼—6¾	..	4 8 11
40,000	5	,,	6	Do. New, £4 paid	4¼—4¾	..	5 1 1
880,000	Stk.	Feb. 23	12	Brentford Consolidated	250—260	..	4 12 4
270,000	,,	,,	9	Do. New	195—200	..	4 10 0
50,000	,,	,,	5	Do. 5 p. c. Pref.	140—145	..	3 9 0
159,375	,,	Dec. 14	4	Do. 4 p. c. Deb.	118—123	..	3 5 1
220,000	Stk.	Mar. 14	11½	Brighton & Hove Orig.	237—242	..	4 15 0
226,320	,,	,,	8½	Do. A. Ord. Stk.	177—182	−3	4 13 5
999,500	Stk.	Feb. 23	5	Bristol, 5 p. c. max.	125—130	..	3 16 11
420,000	20	Mar. 29	10	British	41—42	−½	4 15 3
50,000	10	Feb. 23	12	Bromley, Ord. 10 p. c.	24—26	..	4 12 4
79,000	10	,,	9	Do. 7 p. c.	19—21	..	4 5 8
500,000	10	Oct. 13	6	Buenos Ayres (New) Ltd.	9¼—10	−¼	6 0 0
220,000	Stk.	Dec. 29	4	Do. 4 p. c. Deb.	99—101	..	3 19 3
150,000	20	Mar. 14	8½	Cagliari, Ltd.	24—26	..	6 6 11
100,000	10	Sept. 29	8	Cape Town & Dis., Ltd.	14—15	..	5 6 8
50,000	50	May 2	6	Do. 6 p.c. 1st Mort.	55—57*	..	5 5 3
550,000	Stk.	Apl. 11	13½	Commercial Old Stock	275—285	−17½	4 14 9
236,425	,,	,,	10½	Do. New do.	210—220	−17½	4 15 5
288,237	,,	Dec. 14	4½	Do. 4½ p. c. Deb.	142—145	..	3 2 1
800,000	Stk.	Dec. 14	9	Continental Union, Ltd.	160—170	..	5 5 11
200,000	,,	,,	7	Do. 7 p. c. Pref.	175—180	..	3 17 9
51,600	Stk.	Feb. 23	14	Croydon A 10 p. c.	335—340	..	4 2 4
173,400	,,	,,	11	Do. B 7 p. c.	265—270	..	4 1 5
555,000	Stk.	Feb. 23	5½	Crystal Palace Ord. 5 p. c.	117—122	−1	4 6 1
60,000	,,	,,	5	Do. 5 p. c. Pref.	130—135	..	3 14 1
486,090	10	Jan. 26	11	European, Ltd.	19½—20½	..	5 7 4
854,060	10	,,	11	Do. £7 10s. paid	14½—15½	..	5 6 5
14,993,075	Stk.	Feb. 9	4%	Gas-light and Coke	4 p. c. Ord.	101—103	..	4 15 1
2,600,000	,,	,,	3½		8½ p. c. max.	97—99	..	3 10 8
3,799,735	,,	,,	4		4 p. c. Con. Pref.	118—120	..	3 6 8
3,993,975	,,	Dec. 14	3		3 p. c. Con. Deb.	98—100	..	3 0 0
70,000	10	Nov. 15	8	Hongkong & China, Ltd.		13¾—14½	..	5 10 4
3,800,000	Stk.	Nov. 15	10	Imperial Continental		210—213	..	4 13 11
478,600	Stk.	Feb. 9	8½	Do. 8½ p. c. Deb. Red.		100—103	..	3 8 0
75,000	5	Dec. 14	6	Malta & Medn., Ltd.		4⅞—5⅛	..	5 9 1
560,000	100	Apl. 2	5	Met. of	5 p. c. Deb.	105—109	..	4 11 9
250,000	100	,,	4½	Melbourne	4½ p. c. Deb.	105—107	..	4 4 1
541,920	20	Nov. 15	3	Monte Video, Ltd.		10¾—11½	..	5 4 4
667,946	Stk.	Feb. 23	9½	Newc'tle & Gatesh'd Con.		215—220	..	4 4 1
299,855	Stk.	Dec. 29	8½	Do. 8½ p. c. Deb.		104—107	..	3 5 5
150,000	5	Nov. 30	8	Oriental, Ltd.		7—7½	..	5 6 8
135,000	5	,,	8	Do. New, £4 10s. pd.		6½—6¾	..	5 6 8
15,000	5	,,	8	Do. do. 1879, £1 pd.		1¼—1½	..	4 11 5

Issue.	Share.	When ex-Dividend.	Dividend or Dividend & Bonus.	NAME.	Closing Prices.	Rise or Fall in Wk.	Yield upon Investment.
£			p. c.	GAS COMPANIES.			£ s. d.
50,000	5	Feb. 23	7	Ottoman, Ltd.	5—5¼	..	6 7 3
500,000	100	Dec. 1	6	People's Gas of Chicago 2nd Mtg. Bonds	102—106	..	5 13 2
851,070	10	Apl. 27	7	River Plate Ord.	10¾—11¼*	..	6 4 5
250,000	Stk.	Dec. 29	4	Do. 4 p. c. Deb.	100—102	..	3 18 5
250,000	10	Apl. 11	8	San Paulo, Ltd.	11½—12½	..	6 8 0
185,000	Stk.	Mar. 14	10	Sheffield A.	245—247	..	4 1 0
209,053	,,	,,	10	Do. B.	244—246	..	4 1 4
447,427	,,	,,	10	Do. C.	244—246	..	4 1 4
5,600,000	Stk.	Feb. 23	5½	South Metrop., 4 p.c. Ord.	127—130	−1	4 2 0
1,520,000	,,	Jan. 12	3	Do. 3 p. c. Deb.	99—101	..	2 19 5
380,940	Stk.	Nov. 30	5	Southampton Ord.	117—122	..	4 2 0
70,825	,,	Dec. 29	4	Do. 4 p.c. Deb.	120—125	..	3 4 0
120,000	Stk.	Mar. 14	6	Tottenham and Edmonton A. 5 p.c. B. 3½ p.c. 4 p. c. Deb.	139—141	..	4 5 1
250,520	,,	,,	4½		100—102	..	4 8 3
55,100	,,	Dec. 14	4		113—117	..	3 8 5
182,380	10	Jan. 12	5	Tuscan, Ltd.	7¼—8½	−½	5 17 8
149,900	10	Jan. 2	5	Do. 5 p. c. Deb. Red.	101—104	..	4 16 2
				WATER COMPANIES.			
780,399	Stk.	Dec. 29	11	Chelsea, Ord.	305—310	..	3 11 0
150,000	,,	,,	5	Do. 5 p. c. Pref.	157—162	..	3 1 9
160,000	,,	,,	4½	Do. 4½ p. c. Pref. '75	145—150	..	3 0 0
175,785	,,	Mar. 29	4½	Do. 4½ p. c. Deb.	145—150	..	3 0 0
1,720,560	Stk.	Apl. 11	7	East London, Ord.	195—200	..	3 10 0
654,740	,,	Dec. 29	4½	Do. 4½ p. c. Deb.	145—150	..	3 0 0
390,000	,,	,,	3	Do. 3 p. c. Deb.	99—101	..	2 19 5
700,000	50	Dec. 14	7½	Grand Junction 10 p. c. max. 4 p. c. Deb.	106—108	..	3 9 5
310,000	Stk.	Mar. 29	4		130—135	..	2 19 3
708,000	Stk.	Feb. 23	14	Kent	307—312	..	4 9 9
160,000	,,	,,	7	Do. New, 7 p. c. max.	200—210	..	3 6 8
1,043,800	100	Dec. 29	10½	Lambeth, 10 p. c. max.	294—299	..	3 10 3
406,200	100	,,	8	Do. 7½ p. c. max.	212—217	..	3 13 9
350,000	Stk.	Mar. 29	4	Do. 4 p. c. Deb.	130—133	..	3 0 2
500,000	100	Feb. 23	13½	New River, New Shares	418—423	..	3 3 9
1,000,000	Stk.	Jan. 26	4	Do. 4 p. c. Deb.	132—137	..	2 18 5
902,300	Stk.	Dec. 14	7½	South-wark Ord. 7½ p. c. max. 5 p. c. Pref.	200—205	..	3 13 2
126,500	100	,,	7½		190—195	..	3 16 11
489,200	Stk.	,,	5		160—165	..	3 0 7
1,019,585	,,	Apl. 11	4	Vauxhall 4 p. c. A Deb.	129—134	..	2 19 9
1,155,066	Stk.	Dec. 14	10	West Middlesex	287—292	..	3 8 6
200,000	,,	,,	4½	Do. 4½ p. c. Deb.	147—152	..	2 19 3
200,000	,,	Mar. 14	8	Do. 8 p. c. Deb.	99—101	..	2 19 5

*Ex div.

to take place with regard to deliveries. During the winter months, they took deliveries under contract of something like 70 per cent., and in the summer months of 30 per cent. The colliery owners, and particularly those dealing with the five towns mentioned, were asking that the deliveries should be over equal periods. This meant that they would have to find storage accommodation, and would have to stock the coal at a probable cost of 1s. 6d. per ton, and that the coal when taken to the retorts would be very much deteriorated. These things would have to be taken into calculation when the Committee met to consider the increase in the price of gas. It was anticipated that the amount required in order to deal with the increased cost of coal would be something like £7000; and the lowest increase, putting it down at 3d. per 1000 feet on the consumers now paying 2s. 3d. and 2s. 6d., would only produce £1400, leaving out the ordinary consumers at 2s. 9d., and the automatic meters. Seeing they had had an abnormal year in repairs, it was possible that these might be something like £2000 less next year, and that the coke contracts which would have to be entered into in a short time would make £2000 more than last year, and adding to these figures the present surplus profit of £2000, they would get an amount about equal to the extra cost of coal.

Alderman J. Mason seconded the motion, which was passed.

THE WORK OF THE PUBLIC HEALTH DEPARTMENT OF THE CORPORATION OF LONDON IN THE PAST YEAR.

The report of the Engineer of the Public Health Department of the Corporation of London (Mr. D. J. Ross, M.Inst.C.E.), on the works executed during the past year, has lately been issued. It contains, as usual, particulars in regard to the lighting of the City streets by gas and electricity, and the use of water for sanitary purposes, &c.

The charge for gas in the first half of the year was 2s. 2d. per 1000 cubic feet; but at Midsummer it was reduced to 2s. 1d. The number of lighting hours was 4300. The effect of this change is shown in the following table, which gives the total annual charge per lamp for gas, lighting, and repairing, at the two prices:—

Size.	Description.	Annual Charge at 2s. 2d.	Annual Charge at 2s. 1d.
4 feet . . .	Incandescent	£1 17 3	£1 15 10
5 ,, . . .	Square	3 4 7	3 2 10
5 ,, . . .	Circular	3 8 10	3 7 1
6 ,, . . .	,,	3 18 2	3 16 0
8 ,, . . .	Square	4 12 6	4 9 8
8 ,, . . .	Circular	4 16 9	4 13 11
10 ,, . . .	,,	5 15 5	5 11 10
15 ,, . . .	,,	8 2 0	7 16 8
25 ,, . . .	Special	13 2 11	12 14 0
50 ,, . . .	,,	24 15 10	23 17 11

The charge for repairing the square lamps is 3s., and the circular lamps 7s. 3d. per annum; the difference in charge being due to the additional expense incurred in cleaning and maintaining the round lanterns. There are no charges for lighting and repairing the incandescent lamps. A sum of 15s. per lamp is charged for lighting the lamps up to 20 feet consumption per hour; the charge for the 25 and 50 feet lamps being £1 10s. each. The number of defective gas-lights observed during the year was 192. Returns of these are made daily by the City Police, and include only those lamps in which defective lighting is very noticeable. The number of gas-lamps paid for by the Corporation at the end of the year was 1906; about one-third having been removed, in consequence of the main thoroughfares being lighted by electric lamps. The 36 meters attached to the public lamps in various parts of the City show that the full contract quantity of gas is given at these lamps. The Inspector of Gas Lighting is of opinion that the contract quantity is furnished generally throughout the City, and that the regulators of the lamps are kept in proper condition. The public lamps, both gas and electric, were lighted, in accordance with the general instructions in force for many years past, whenever fog or unusual darkness occurred. This happened on nineteen days during the year. The experimental lighting in Wood Street with the Welsbach incandescent gas-lamps, and in Great St. Helen's with the same system, was continued throughout the year. The Denayrouze burners in the refuge lamps at Great St. Helen's and Blackfriars Bridge Approach were removed at the end of November in favour of the Welsbach Company's No. 4 Kern burners. Basinghall Street has been lighted experimentally, since Nov. 14, 1898, with the Sunlight Company's new incandescent gas-burners and lanterns; the experiment being conducted at the expense of the Company. In December, Fetter Lane was experimentally lighted by incandescent gas-lamps with Kern burners. The Engineer says these lamps are "a great improvement on the old system of lighting." The lamps are 24 in number, including one in Fleur-de-Lis Court. The cost of maintenance and gas supplied is £73 15s. per annum, as compared with £79 12s. by the old system; and the illuminating power claimed for the lamps is 90 candles each, as compared with the 14-candle power of the old lamps. Instructions have recently been given for the experimental incandescent lamps and burners in Wood Street and Great St. Helen's to be removed, and replaced with Kern burners.

Reference is made to the proceedings in Parliament on the Bill of the Gaslight and Coke Company to enable them to raise additional capital to the amount of £3,500,000; and to the inquiry by a Committee of the House of Commons into the charges of the Metropolitan Gas Companies. The progress of these inquiries was watched by a Sub-Committee of the Streets Committee, and the latter presented a report. The Sub-Committee and the Corporation officials co-operated with the London County Council; and they congratulated the Corporation on being able to assist the gas consumers, not only within the City, but in nearly the whole of the Metropolis on the north side of the Thames, representing a population of 2,389,000, and a rateable value of £25,660,000. The Committee went on to say: "The difference in price between the two Companies represents a sum of £800,000 per annum on

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	Cubic Feet Daily.
BLACKBURN	1,250,000
WINDSOR ST. WORKS, BIRMINGHAM	2,000,000
SALTLEY WORKS, BIRMINGHAM	2,000,000
COLCHESTER	300,000
BIRKENHEAD	2,250,000
SWINDON (New Swindon Gas Co.)	120,000
SALTLEY, BIRMINGHAM (Second Contract)	2,000,000
WINDSOR ST., BIRMINGHAM (Second Cont.)	2,000,000
HALIFAX	1,000,000
TORONTO	250,000
OTTAWA	250,000
LINDSAY (Remodelled)	125,000
MONTREAL	500,000
TORONTO (Second Contract; Remodelled)	2,000,000
BELLEVILLE	250,000
OTTAWA (Second Contract)	250,000
BRANTFORD (Remodelled)	200,000
ST. CATHERINES (Remodelled)	250,000
KINGSTON, PA.	125,000
PETERBOROUGH, ONT.	250,000
WILKESBARRE, PA.	750,000
ST. CATHERINES (Second Contract)	250,000

	Cubic Feet Daily.
BUFFALO, N.Y.	2,000,000
WINNIPEG, MAN.	500,000
COLCHESTER (Second Contract)	300,000
YORK	750,000
ROCHESTER	500,000
KINGSTON, ONT.,	300,000
CRYSTAL PALACE DISTRICT	2,000,000
DULUTH, MINN.	300,000
CATERHAM	150,000
LEICESTER	2,000,000
ENSCHEDE (HOLLAND)	150,000
BUENOS AYRES (RIVER PLATE CO.)	700,000
BURNLEY	1,500,000
KINGSTON-ON-THAMES	1,750,000
ACCRINGTON	500,000
TONBRIDGE	300,000
STRETFORD	500,000
OLDBURY	300,000
TODMORDEN	500,000
SALTLEY, BIRMINGHAM (Third Contract)	2,000,000
YORK (Second Contract)	750,000

the Gaslight and Coke Company's yearly output of about 21,000 million cubic feet, of which sum the Corporation pay annually nearly £3000. This large sum of money is the extra annual burden upon the gas consumers north of the Thames. Why gas should cost on the north side of the Thames nearly 3s. per 1000 cubic feet, and only 2s. 2d. per 1000 cubic feet on the south side,* is a mystery yet to be solved; but it is clear that this monopolist Company must either reduce its charge, or, in common fairness to the citizens, competition must be allowed, at least to the extent of permitting the South Metropolitan Gas Company to cross the Thames and supply those who desire it with gas at 2s. 2d. per 1000 feet."

With regard to the electric lighting of the City, this system was in use in the main thoroughfares throughout the year; the number of lamps in service on Dec. 31 being 507. The question of lighting the side streets by electricity is still under consideration. The number of defective electric lamps observed during the year was 896. Returns on this matter are made daily to the Engineer by the police; and the City of London Electric Light Company are fined for each failure.

The cost of water used for flushing and other purposes last year was £3737 4s. 3d., as compared with £3736 0s. 11d. in 1898. Owing to the action taken by the Streets Committee, the charge for water supplied by the New River Company for street-watering purposes has been reduced from 8½d. to 6d. per 1000 gallons for quantities over 200,000 gallons; and this is the charge now for all water supplied by the Company for public purposes. In order to save the expense of the Company's men attending to check the quantity of water taken from the street hydrants, 25 experimental hydrants have been fixed with meters attached. The results of this experiment are still under consideration. The quantity of water used during the year for washing the streets and courts was 29,439,551 gallons; the number of nights on which it was employed being 285. The streets were washed more frequently last year than ever before.

As in previous reports, information is furnished with regard to the extent to which the subways for gas, water, and other pipes in the City streets are used, especially in view of the Bill of the Corporation, in which this is a prominent feature, now before Parliament. Beneath the thoroughfares under the control of the Corporation there exist at the present time about 2540 lineal yards, or 1½ miles, of subways. The lengths of gas, water, and hydraulic mains, telegraph and pneumatic tubes, and electric lighting conduits laid in these subways amount to over 8 miles. The electric light and telegraph conduits contain about 447 miles of wires and cables. The Engineer states that "the usefulness of these subways is evidenced by the fact that in the streets beneath which they have been constructed no openings have been made for access to pipes, &c., except those for taking pipes into the ends of the subways, since they were constructed." Access, under proper supervision, is given to the officers and workmen of the various companies. The Inspector of Subways reports that 4736 workmen and others were admitted during the year. A new subway, about 440 feet in length, was formed last year under the new thoroughfare known as "Lloyd's Avenue."

* Subsequently to the date of the report, the price was reduced to 2s. 1d. —Ed. J.G.L.

ELECTRIC LIGHTING NOTES.

The Longton Corporation have resolved to apply for sanction to a loan of £28,500 for an electric light installation for the borough.

The Electricity Committee of the Bradford Corporation have decided to fix the charge for electricity for motive power with continuous user through the working hours of the day at 1d. per unit, and for intermittent user at 2d. per unit.

The Worcester City Council have resolved to apply to the Local Government Board for a loan of £1000 to enable them to carry on the system of free wiring for private users of the electric light—the Free Wiring Company being dissatisfied with the terms. It is stated that, if the loan is granted, Worcester will be the first Corporation to do free wiring.

The Electrical Engineer of the Cardiff Corporation (Mr. N. Appelbee) has reported to his Committee that the increase in the number of private lamps connected last year was equal to the increase of the two preceding years. The quantity of electricity sold was 509,000 units; while in the preceding year it was 405,000 units. The charge during the quarter was 4½d. per unit; and there was a deficit of £1000, which appears to be due to the public lighting. Mr. Appelbee urges the consideration of the provision of additional plant, as at the present rate of progress the existing station will be fully occupied in two or three years' time. In his opinion, a new station should be erected, in preference to extending on the present site.

Mr. E. A. Sandford Fawcett, of the Local Government Board, held an inquiry at Redditch last Thursday, respecting an application by the District Council for permission to borrow £8000 for work in connection with the electric lighting scheme. The Clerk (Mr. J. W. Hobson) said the reasons for making this application shortly after the sanction to a loan of £10,911, were excess of expenditure over the former loan, and success of the undertaking. The pressure on the plant was equal to 80 per cent. of its total capacity, and extensions were absolutely necessary. Plans of the proposed improvements and extensions were submitted by the Engineer; and the Inspector said he did not think it necessary to call further evidence.

The report of the Calcutta Electric Supply Corporation, Limited, for 1899 states that the supply of electrical energy began on April 17, 1899, and at the 31st of December there were connected to the Company's mains an equivalent of 9463 lamps of 8-candle power, of which 8170 lamps were for lighting purposes, and the equivalent of 1293 lamps for power. 54,897 units were sold (42,947 for lighting and 14,850 for power), and the gross revenue was £2041, while the costs, after charging the management and administration expenses to revenue, amounted to £1389, leaving a net profit of £651, which it is proposed to carry forward. Additional mains have been laid in many of the streets in Calcutta beyond those comprised in the original contract; and the report states that many more will soon be required, and further considerable capital expenditure will have to be incurred for the supply to the new districts. Under these circumstances, the Directors propose that the nominal capital of the Company shall be increased to £200,000 by the creation of 20,000 additional shares of £5 each.

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SULPHATE OF AMMONIA PLANTS.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The Edinburgh and Leith Gas Commissioners, on Monday, entered into their contracts for the year. A discreet silence was maintained by them as to the prices agreed upon for coal and oil. Their resolution was to contract for coal for either six or twelve months, as might seem most advantageous. The contracts which have been fixed are for twelve months. They have contracted for, in all, 122,500 tons of coal, and 3000 tons of oil. The oil is the same in quantity as last year, so it is evident that there is no intention to increase the output of carburetted water gas. The coal is considerably less in quantity than last year. In the course of the twelve months which expired at May 15 last year, the quantity of coal carbonized was 154,000 tons. This would point to the Commissioners either having a large stock of coal on hand, or to their trusting to buy during the next year, as the market offers. I think that, on mature reflection, they have done well to contract for the whole year. For the 122,500 tons which the Edinburgh and Leith Commissioners have contracted, there are eight contractors. The Lothian Coal Company hold the contract for 20,000 tons; Messrs. A. Russell and Co., of Glasgow, for 32,500 tons; the Niddrie and Benhar Coal Company, for 43,000 tons; Messrs. J. M'Kelvie and Co., of Edinburgh, for 10,000 tons; Messrs. Henry Ness and Co., of Fife, for 3000 tons; Messrs. Gavin Paul and Sons, of Edinburgh, for 10,000 tons; Messrs. James Sword and Son, of Leith, for 3000 tons; and the Lochore and Capledrae Coal Company, for 1000 tons. I have given the list of contractors, to let it be seen how careful the Commissioners have been to lay in coal which is won in their own district, thereby doing away with heavy railway charges. Now that these have been raised, the item would have been a considerable one. As the coal will be delivered free, it is probable that West of Scotland coal has been prejudiced, in this contract, by the railway charges. I understand that the subject of the raising of the railway rates is to be referred to the Railway Commission. But their decision cannot be expected before July, or even October; and it will thus be too late to affect prices in the contracting season this year. The contracts for Edinburgh and Leith consist of 37,000 tons of high-class cannels, 10,000 tons of shale, and the balance is chiefly splints. The oil contract has been secured, as last year, by the Broxburn Oil Company.

The Commissioners had before them a report by the Works Committee upon the subject of the lighting of streets by incandescent gas-lamps, and they instructed that the report, along with a tender by Messrs. James Milne and Son, to supply large quantities of lanterns, should be communicated to the Corporations of Edinburgh and Leith. The cost will be £3 0s. 6d. per lamp, which is the amount calculated by the Engineer (Mr. W. R. Herring) for supplying and fitting up lanterns. Mr. Herring also reported to the Committee that the destruction of mantles during one year had been in the following percentage: Lutton Place 6·2, Meadow Walk 4, Drummond Street 5·6, Melville Street 6·2, St. Andrew Square 4, New Street 5·6, and Leith Docks 5·16. These figures are instructive. In Meadow Walk there is no vehicular traffic; and in St. Andrew Square the incandescent lamps are fitted upon pillars of great mass and substantiality. These are the two lowest in the matter of breakages. It is thus apparent that vibration has a great deal to do with the life of an incandescent mantle.

The Commissioners agreed to provide gas to the Corporations of Edinburgh and Leith for a year, for street and common stair lighting, at the rate of 2s. 8d. per 1000 cubic feet. This is 4d. per 1000 feet below the present ordinary rate.

It was reported that the output of gas during March showed an increase upon the corresponding month of last year of 11,979,000 cubic feet; and that since May 16, the increase over the corresponding period of last year had been 95,886,000 cubic feet. Speaking to these figures, Judge Kinloch Anderson said that the increase during March was at the rate of 7·6 per cent.; and since May 16 at the rate of 5·80 per cent. He considered the results to be satisfactory.

A Committee of the Edinburgh Town Council have this week fixed the estimate for the lighting of the city during the year from May 15, at £37,000. I have not the figures by me; but I recollect that twelve years ago the estimate was about £14,000. The city has not increased in the same ratio; but we live in more luxurious times.

There are no people in the world who are so selfish as those who essay to represent the working classes. We had in Dundee, this week, the body styling themselves the Dundee Trades and Labour Council, formally adopting a protest against the proposal by the Town Council to advance the salary of Mr. W. M'Crae, the Gas Manager, by £50 a year. The resolution was transmitted to the Town Council, who had the subject before them on the succeeding day, as a recommendation from their Gas Committee. There the resolution of the Trades and Labour Council found the support of two members only. These gentlemen appeared to have been red-hot in their profession of labourism; for they could not wait till the recommendation was moved, but as soon as the subject was reached moved the rejection of the proposal. Of course, the approval was then moved. There was no argument against the granting of the increase; and the only argument in its favour was the sufficient one that a great deal of extra work had been thrown upon Mr. M'Crae. The increase was thus granted. This, in ordinary circumstances, would be all I should say upon the subject; but I began by referring to the selfishness of the working-class representatives. At the meeting of the Trades and Labour Council, the theory of the opposition was not that the increase was not warranted, but that there was a mania for increasing salaries at present. The doctrine was that, as members of trades unions would have to contribute to the increase of the salary of the Gas Manager, therefore it must be opposed. And this, too, by people who are continually moving for more wages for themselves, whenever the opportunity offers—whether a rise be warranted or not. The species of logic which appeals to working men is of a very crude sort. The speaker would like to know why gas was so much dearer in Dundee than it was in other places, and he thought there should be a strict investigation into the management, with a view to finding that out. The insinuation was that the Manager was to blame for the high price of the gas, which is not the case, as a few minutes' study of the history of the town would have

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satisfied him. It is known to all who care to look into the matter that, in the departments of both gas and water, Dundee has been unfortunate; but the reason for this has lain with the public men of the place, and not with the officials. Even yet there is a lack of foresight among Dundee public men, because, at this week's meeting of the Town Council, a proposal to pave one of the leading streets with wood was rejected by a large majority, on the score of expense. The equipment of the town is not of so much consequence as the keeping down of the cost. This would be a slight departure from my subject, were it not that the same spirit has overhung all the steps which are being taken at present for the reconstruction of the gas-works. It is right, however, to acknowledge that they have shown a proper spirit this time. Mr. M'Crae evidently has the confidence of the Council, and upon this he is to be congratulated more than upon the addition to his salary.

The Finance Sub-Committee of the Water Committee of the Glasgow Corporation recommend that the water rates and charges remain the same during the ensuing year as at present. The domestic rate within the compulsory area is 5d. in the pound, and outside the compulsory area it is 10d.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *May 5.*

Sulphate of Ammonia.—The market has been fairly steady; and the closing quotations are £11 5s. to £11 8s. 9d. per ton, delivered f.o.b. at the ports. There has been more inquiry; but the efforts of buyers are being directed to securing still further concessions in prices. These have been partly successful; there being speculative offering abroad at below the equivalent of makers' quotations. The smaller makes offered have been disposed of, mostly at a slight decline; but some of the larger makes are being firmly held for the chance of some recovery in values as the month progresses. In the forward position, Scotch makers are very firm; but in London there is some disposition to meet buyers. There is still good inquiry for summer months; and prompt prices would be paid for June-August delivery.

Nitrate of Soda is decidedly firmer on spot; the quotations being 8s. 4½d. per cwt. for ordinary, and 8s. 7½d. for fine quality. Hamburg is getting short; and still higher prices would be paid for cargoes arrived at port of call.

LONDON, *May 5.*

Tar Products.—In sympathy with the advanced prices of fuel everywhere, pitch is strong for prompt delivery; and for forward delivery higher prices are being asked. There is an excellent business in carbolic acid, which is now again scarce. A better market exists for solvent and heavy naphthas; but there is no improvement in price. A good deal more inquiry comes to hand for benzol; and it is important to remember that makers have no stocks of this. In one notable instance, it is reported that there has been large over-selling. Anthracene is steady, with a reducing production; while for naphthalene there is a firm market at rates quoted below. For tar rich in carbolic and other tar acids, stiff prices are being paid; but this only applies to country tars, as east coast and London tars contain little or no phenols.

The average values obtaining during the week are: Tar, 17s. 6d. to 27s. 6d. Pitch, east coast, 38s.; west coast, 35s. Benzol, 90's, 6d.; special qualities for gas, 8d.; 50's, 8d. Toluol, 90's, 1s. Solvent naphtha, 1s. 1d. Crude naphtha, 3½d. Heavy naphtha, 11d. Creosote, 2¾d. Heavy oils, 3¼d. Carbolic acid, 50's, 2s. 3d.; 60's, 2s. 9d. Naphthalene, 55s. to 75s. Anthracene, "A," 4d.; "B," 3d.

Sulphate of Ammonia is dull. There seems to be a conspiracy of silence on the part of buyers, and particularly of middlemen, who are interested in lower prices. Fortunately, very little stuff is offering; and it is felt that the serious fall in value which has taken place can only be of a temporary character. Quotations to-day are nominal only, no business being reported; but they may be recorded at an average of £11 5s. per ton, less 3½ per cent.

COAL TRADE REPORTS.

From Our Own Correspondents.

Lancashire Coal Trade.—Business is gradually coming forward in gas coal; and some further contracts have been settled during the past week, on the full basis of 5s. a ton over last year's rates. In fact, in one instance as much as 6s. over the 1899 contract price is reported to have been obtained; but in this case, no doubt, last year's figures were somewhat below the average. With respect to other descriptions of fuel, the position remains very much as recently recorded. Supplies all round continue short; and collieries have more than they can do, with their present output, to keep up deliveries to customers. The extraordinary feature is that house-fire requirements are taking away all the better qualities of round coal that collieries have to offer, and that some local coalowners are still compelled to purchase in other districts to meet the needs of their customers. Steam and forge coals and engine fuel are in much the same pressing demand as for some time past; and no difficulty has been experienced in getting the advance upon the slack. But it can scarcely be said that, on current sales, the advance of 6s. per ton over last year's contract prices for steam and forge coals has so far been established on inland sales for present delivery, though coalowners are declining to sell forward except at the full basis. The result is that buying is to a considerable extent restricted to present requirements; consumers not caring to commit themselves very far ahead at the high prices now ruling. But whether they will gain any advantage by waiting, seems to be more than doubtful. At the pit, best Arley coals average 15s. to 15s. 6d. per ton, medium sorts and Pemberton four-feet 13s. 6d. to 14s. 6d., steam and forge coal 12s. 6d. to 13s., and slack from 10s. 6d. up to 11s. 6d. Only a moderate business comes forward in the shipping trade; and though the official price for steam coal at Mersey ports is still 16s. per ton, there are continued reports that some concession on this figure is being made in isolated cases to secure orders. Coke is in

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LONDON & BIRMINGHAM.

pressing request, with makers short of supplies to meet customers' requirements, and prices firm with a hardening tendency.

Northern Coal Trade.—There is again a strong demand both for steam and gas coals; and though the movements in prices have not been very great, the tendency has been decidedly to firmness. Best Northumbrian steam coals are firm at about 19s. per ton f.o.b.; and steam smalls are 13s. to 13s. 6d.—the latter being very scarce. The commencement of the Baltic season is giving increased briskness to the demand for Northumbrian coals generally. Gas coals are in good demand; and there are heavy shipments, both on old contracts and on some of those that have been recently concluded. For best Durham gas coals, the price is about 17s. per ton f.o.b. for occasional cargoes; while most of the contracts that have been named of late are now settled on a basis that is generally from 15s. 9d. to 16s. 3d. per ton f.o.b., or equal to some such price, if allowance is made for the freight, when that is included. The advance just conceded to the Durham miners will help to stiffen the prices of all classes of Durham coals. In the coke trade, there is considerable briskness for home use and export. Gas coke is now in rather reduced production; and the stocks are low. Prices are still based on about 16s. per ton f.o.b.; but it is expected that the next contracts may see higher prices for gas coke.

Scotch Coal Trade.—The demand for all classes continues, and prices are fully maintained. There are several gas coal contracts still to be completed; and the prospect is not very encouraging to managers. The prices quoted are: Main 14s. to 14s. 3d. per ton f.o.b. Glasgow, ell 15s. 6d. to 16s. 9d., and splint 14s. 9d. to 15s. The shipments for the week amounted to 213,736 tons—an increase of 6268 tons upon the preceding week, and of 23,421 tons upon the corresponding week of last year. For the year to date, the total shipments have been 3,105,582 tons—an increase of 653,556 tons upon the same period of last year.

Sales of Stock and Shares.—At the Mart, Tokenhouse Yard, E.C., last Wednesday, Mr. Alfred Richards sold by auction 2500 fully-paid £10 ordinary (7 per cent.) shares in the West Ham Gas Company, at from £11 5s. to £13 15s. each; the average being £11 13s. 11d., which will yield the purchaser £5 19s. 8d. per cent. The total amount produced by the sale was £29,243. At a sale of £1500 of "E" stock on the previous day, the prices realized were at the rate of £190 per £100 nominal. The dividend under the sliding-scale is 8½ per cent. per annum.

A Cumberland Water Scheme.—The Overwater and High Ellen water scheme—the biggest of its kind yet contemplated by Cumberland Councils—was revived at last Tuesday's meeting of the Wigton Rural District Council. It is proposed to supply the Wigton, Aspatria, Holme, Cultram, and neighbouring districts from Lake Overwater and the upper reaches of the River Ellen. Engineers estimate the cost of the trunk main at £30,000. The Wigton Council were now asked to state whether they intended to support the comprehensive scheme, or leave it to private enterprise. Before arriving at any definite conclusion, it was decided to approach the Wigton District Council, with a view to a supply of water being secured from their mains for the districts below Wigton.

Sale of the Old Hull Gas-Works.—The unsold portions of the old gas-works in Broadley Street, Hull, which were to have been disposed of by public auction, have been purchased privately by Messrs. Mordaunt, Lawson, and Co., of Middlesbrough, for breaking-up purposes. They have been allowed three months for clearing them away. It is locally reported that the price which the Corporation will receive exceeds by several hundred pounds the amount which the sale by auction was expected to realize.

Georgetown (British Guiana) Gas Company.—The report of the Directors submitted at the half-yearly meeting of the Company last Tuesday stated that the profit for the half year ended Dec. 31 last amounted to £50 7s. 11d., and after adding the balance from the previous six months and transferring the sum of £100 from the reserve fund, the balance remaining, after deducting interest on bonds, &c., was £3 14s. The Directors were therefore unable to recommend the payment of any dividend. The report and accounts were adopted without comment; and the retiring Directors (Messrs. Alfred Lass and H. W. Andrews) and Auditor (Mr. H. J. Hartley) were re-elected. Owing to the small attendance at the meeting, it was agreed, on the suggestion of the Chairman (Mr. Charles Gandon), to adjourn the proceedings till the 29th inst., when it was hoped that as many of the shareholders as possible would make it convenient to attend.

Fatality at the Beckton Gas-Works.—Last Tuesday, Mr. George E. Hilleary concluded an inquiry into the death of John Lavis, 38, lately a labourer in the purifying department of the Beckton Gas-Works, who returned home from work on the afternoon of the 11th ult., complaining of being ill. He began vomiting large quanities of blood, and died on the following morning. Mr. Thomas Goulden, the Superintendent of the works, said he heard of nothing unusual on the day in question, when deceased and a number of other men were engaged in cleaning out one of the purifiers; in fact, he had never before known of men getting "gassed" in the purifiers. Since Lavis's death, two other men had suffered through the gas, and had not been able to come back to work. Before the men entered the purifier to cleanse it, the cover was taken off and air blown through it for six hours. He did not think that after that time there would be any dangerous places. Dr. Jordan Harvey stated that at a *post-mortem* examination he found the body was stained a yellowish green colour, while all the internal organs were a dark grey. Death was due to shock through some noxious agent in the blood, but it was not ptomaine poisoning, although he was unable to say what the agent was. Dr. Atkins Grogono, who, in company with Dr. Pepper, of St. Mary's Hospital, made a subsequent examination, partly agreed as to the staining of the body, and said the cause of death was sulphuretted hydrogen poisoning through inhaling the gas. The symptoms were not consistent with ptomaine poisoning. Dr. Pepper disagreed with this, and said that, in his opinion, the appearances pointed to ptomaine poisoning; while Mr. Goulden (recalled) said that it was impossible for deceased to have inhaled the sulphuretted hydrogen gas in the purifier. The Jury returned a verdict that deceased died from sulphuretted hydrogen poisoning, and added a rider that, in their opinion, sufficient precautions were not taken in purifying the house in which deceased worked.

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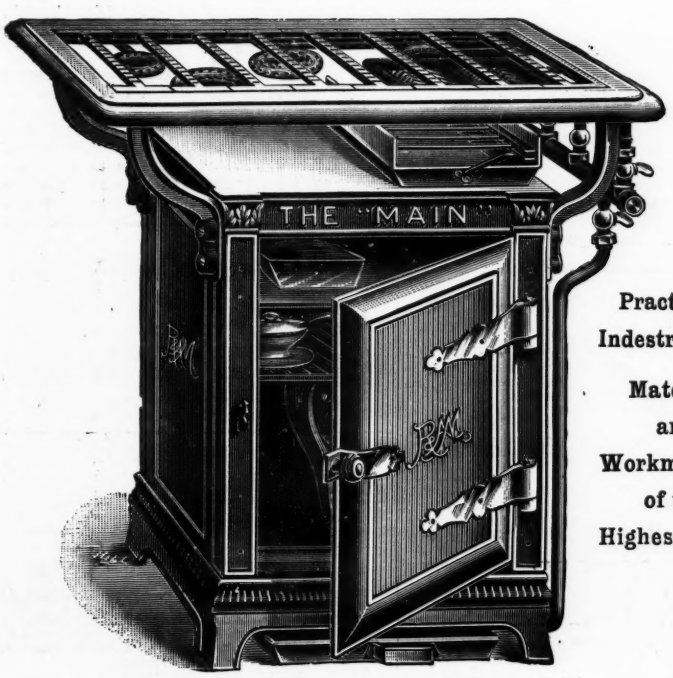

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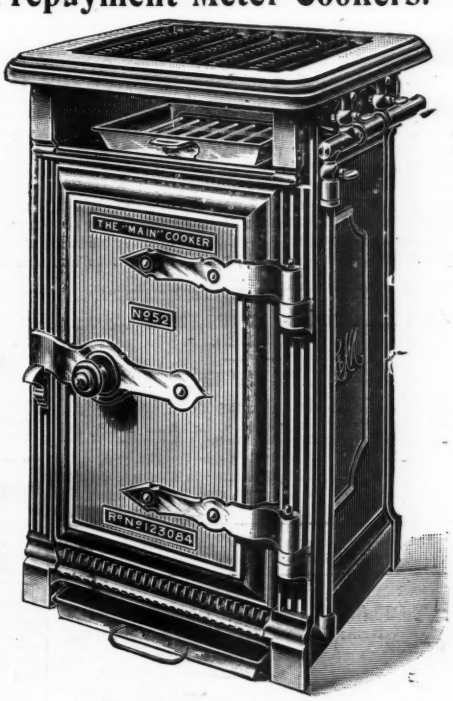

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Lambeth Water-Works Company.—The Directors of this Company have decided, subject to audit, to transfer £10,000 to the contingency fund, and to recommend the payment of a dividend for the past half year at the prescribed rates of 10 per cent. and 7½ per cent. per annum respectively on the share capital of the Company, together with a further payment at the rate of ½ per cent. per annum on both classes of shares on account of arrears of previous dividends; leaving about £2000 to be carried forward after making provision for the statutory payment to the sinking fund.

Brixham Water Supply.—After some months of unavailing effort, the members of the Brixham District Council have decided to abandon the search for water for the supply of the locality. Half of the loan of £500 sanctioned for the purpose of finding a water supply has been expended, and the charges in respect of this involve a rate of 1d. in the pound. The Water Committee, who formerly had oversight of the operations, were in favour of continuing them; but the Committee appointed after the recent election of the Council decided to abandon the works, and a majority of the Council have approved of this course.

Okehampton Water Supply.—Proposals for improving the water supply of Okehampton have been under the consideration of the Town Council for a considerable time, and recently a scheme which is to cost £1600 was adopted, subject to the approval of the Local Government Board. At a meeting of the Council last Wednesday week, it was stated by the Mayor (Mr. R. F. Brealy) that the question of the supply of water was becoming very pressing. A meeting of the ratepayers had been held, at which resolutions were passed calling upon the Council to urge the Local Government Board to sanction the scheme as soon as possible, and in the meantime to take steps to stop the leakage, and make the best of the present supply. Many of the pipes were undoubtedly worn out, and the system generally was very defective. It was decided to consult a water engineer both as to the present supply and the proposed scheme.

Suggested Purchase of the Aldershot Gas and Water Works by the District Council.—At the meeting of the Aldershot District Council last Wednesday, the youngest member of the body—Mr. C. A. L. Calvert—distinguished himself by submitting a proposal for the purchase of the undertaking of the Gas and Water Company. He did not, however, appear to have very seriously considered the financial aspect of the question; and his proposal was severely criticized by one of the members. In the result, the question was referred to a Special Committee. The suggestion is not being favourably regarded by the local Press. It is estimated that the purchase would cost about £400,000, and entail an annual expenditure of £14,300; and the ratepayers will probably hesitate to take this burden upon themselves in face of the Council's scheme of electric lighting, and the possibility of the Government providing their own water supply, and extending their already formulated project for putting in the electric light.

Slough Gas Company.—The half-yearly general meeting of this Company was held last Tuesday—Mr. R. Martin in the chair. The Directors reported that the net profit for the six months covered by the accounts would enable them to recommend the payment of the statutory dividends. In moving the adoption of the report, the Chairman said the Directors had already lowered the price of gas 3d. per 1000 cubic feet, and they had intended to reduce it another 3d.; but they found they could not do it, as coals had gone up to such an extent that the cost to them would be increased £800 a year. Coals which they had been buying at 15s. 11d. a ton had gone up to 24s. 6d. He attributed this to a "ring" of the coalowners, and he hoped they would burn their fingers with it. He thought the Directors would be able to pull through without raising the charge for gas; but he found that all round the neighbourhood the gas companies were putting up their price 6d., 9d., and 1s. per 1000 cubic feet. The report was adopted.

The Dorking Local Authorities and the Water Company's Bill.—At the last meeting of the Dorking Urban District Council, Mr. Palmer reported the result of the joint action of the Committees of the Urban and Rural Councils in regard to the Bill of the Dorking Water Company. Having read the new clauses, he proceeded to point out that it had been suggested to him whether provision could be obtained whereby it would be unnecessary for the Council to apply to Parliament in future—in other words, whether the present Act should include provisions under which the Council could purchase. He instructed the Clerk to place the matter before their Parliamentary Agents, who replied that the suggestion could not be carried out, as it would practically make the Bill one for compulsorily obtaining the undertaking of the Company. It therefore went through with the clauses prepared by the Sub-Committee. Mr. Palmer further stated that the Council were empowered to apply for a Bill in the next or the succeeding session; and after this Bill was passed, they had power within, he believed, twelve months to exercise their option. He took it that it would be advisable for the new Council to seriously consider the advisability of bringing the matter to an issue at once.

Progress of the Birmingham Water Scheme.—The Chairman (Alderman Lawley Parker) and members of the Water Committee of the Birmingham Corporation left the city for Wales on the 26th ult., for the purpose of inspecting the progress of the work in connection with the Elan water supply. On their arrival, a consultation took place with the Engineer (Mr. J. Mansergh), the Town Clerk (Mr. E. O. Smith), and the Resident Engineer (Mr. Yourdi). An early start was made on Friday, and the Committee first inspected the submerged dam at Caregddu, where the viaduct arches present a marked feature—stretching nearly across the valley. Subsequently the party visited the dams at Craig Coch and Pen-y-Gareg, at both of which places a good idea can now be formed of the ultimate height of the dams. Returning to the Caban Coch, an inspection was made of the dam. Here the masonry of the centre and final section has recently been commenced. The afternoon was spent in a visit to the village and the works in the Claerwen Valley, above Nantgwillt, where the boring of the tunnel to carry the waters of the Claerwen to the Caban reservoir above the submerged dam is now in progress. The Chairman took the opportunity, on behalf of the Committee, of congratulating Mr. Mansergh on his appointment to the presidency of the Institution of Civil Engineers. The party returned to Birmingham on Saturday.

The Malvern District Council have decided to apply for a further loan of £3000 for the purchase of gas cooking-stoves and slot meters.

The issue of 1500 new ordinary £10 shares by the Pontypridd Water-Works Company has resulted in a premium of about £5600. The issue was over-applied for by £10,000.

Mr. Joseph Eden, of Workington, has been appointed Engineer for the new water-works of the Corporation at a salary of £650 per annum; and he is to have the assistance of Mr. E. M. Eaton, M.Inst.C.E., for consultation purposes.

We have received from the Commissioner for Labour (Mr. H. Llewellyn Smith) a copy of the "Directory of Industrial Associations in the United Kingdom, including Employers' Associations, Trade Unions, Boards of Conciliation and Arbitration, and Workmen's Co-operative Societies," recently issued by the Labour Department of the Board of Trade.

Mr. H. Simmonds, the Engineer and Manager of the Bury Corporation Gas-Works, has had his salary raised by £150 per annum. In submitting the proposal at the meeting of the Council last Thursday, the Mayor (Mr. Byrom) made a very appreciatory reference to the work of Mr. Simmonds during the two years he has been in the service of the Corporation.

The Local Government Board have definitely decided that they have no power to sanction a loan to defray the costs incurred by the Newhaven District Council in promoting and opposing Water Bills in Parliament. The amount is £2462; and it is calculated that this practically means a 2s. 6d. rate. The Council have referred the matter to the General Purposes Committee for their consideration.

The death recently occurred in Paris of an aëronaut from poisoning by hydrogen arsenide, which escaped from his balloon. The occurrence, says "La Nature," points to the necessity of purifying the hydrogen used for balloon purposes. The balloon was filled in the ordinary way, and nothing peculiar was noticed in the character of the gas; but some hours afterwards the persons who had assisted in the operation were taken seriously ill, and one of them did not recover.

Exhibitions of gas appliances have lately been held by the following firms: The Davis Gas-Stove Company, Limited, in Bristol; Messrs. Fletcher, Russell, and Co., at Gorleston, Newcastle, Norwich, and St. Helens; Messrs. R. & A. Main, Limited, in Bristol and Dundee; Messrs. John Wright and Co., Limited, at Leeds and Norwich; and Messrs. Wilson and Mathieson, Limited, at Bury. Lectures and demonstrations for the various firms were given by Miss Dodds, Mrs. Fennah, Mrs. C. Laughton, Mrs. C. F. Pitcher, Mrs. H. M. Young, and Misses Betts, Birkett, Brown, Holroyd, and Wilkinson.

The Otto Hilgenstock Bye-Product and Non-Bye-Product Coke-Ovens and Coal-Washing Company, Limited, has been formed with a capital of £100,000, in £5 shares, to adopt and carry into effect an agreement for the acquisition of certain patents relating to improvements in the construction of coke-ovens, and to develop and turn them to account; further, to "roast, prepare, and otherwise deal with" coal, sand, cannel, &c.; to make coke and extract tar, oil, gas, and other residual products from the same; to construct and maintain coke-ovens, furnaces, gas-works, retorts, works, plant, and machinery, with or without rail or tram roads, and for other purposes.

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Resists 4500° Fahr. Best for use in GAS-WORKS.
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CONDENSER (Morris & Cutler's), 21 ft. 6 in. by 6 ft. 6 in. by 3 ft. 6 in., 1 million per day. Equal to new. Exceptional Bargain, if sold promptly.
Address No. 3463, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

FOR SALE—Two Lancashire Boilers, each 6 ft. diameter by 30 ft. long, with Mountings. Been in use only a short time. Made by the Yorkshire Engine Company, Limited, Sheffield.
Apply to NEWTON, CHAMBERS, & CO., LIMITED, Thorncliffe Iron-Works, near SHEFFIELD, where the Boilers may be seen.

EXHAUSTERS, 1500 to 60,000 feet per hour, with or without Engines.
LIVESEY WASHERS, CUTLER CONDENSER, SCRUBBERS, 5 feet and 6 feet diameter, METERS, GOVERNORS, PURIFIERS (Sets of 6 feet and 10 feet square), BOILER and other TANKS, VALVES, &c.,
J. FIRTH BLAKELEY & Co., Thornhill, DEWSBURY.

GAS PLANT for Sale—I can always offer NEW and SECOND-HAND GAS APPARATUS, including Retorts and Fittings, Condensers, Exhausters, Scrubbers, Washers, Purifiers, Gasholders, Tanks, Valves, Connections, &c. Also a few COMPLETE WORKS. Compare Prices and Particulars before ordering elsewhere.
J. F. BLAKELEY, Gas Engineer, Thornhill, DEWSBURY.

THE Bromsgrove Gaslight and Coke Company, owing to Extensions, have FOR DISPOSAL—
One WASHER-SCRUBBER (by Laycock and Clapham), with 10 inch Connections, made to pass 100,000 cubic feet per diem.
One TOWER-SCRUBBER, 3 feet diameter and 20 feet high, with 10-inch Connections.
The above can be seen at work, and any other Information obtained, on application to the MANAGER.

THE Dawley Gas Company are prepared to receive TENDERS for the supply of a SINGLE-LIFT GASHOLDER, to replace one now in. Size required 40 ft. 3 in. diameter by 12 ft. deep. Present Columns and Pulleys only to remain.
Tenders to be sent in on or before May 21.
Any further Particulars may be had from the SECRETARY.

TONBRIDGE GAS COMPANY.
TENDERS FOR GAS COAL.
THE Directors of the Tonbridge Gas Company invite TENDERS for the supply of about 5000 Tons of GAS COAL delivered at the Tonbridge Station, South-Eastern Railway, or into the Company's Works, by Barges from Rochester.
Delivery to be as required during the year ending May 31, 1901.
Further Particulars may be obtained on application to the undersigned.
Tenders, endorsed "Coal," to be sent in on or before Thursday, May 17, 1900.
JAMES DONALDSON,
Manager and Secretary.

CORPORATION OF LOUGHBOROUGH.

TENDERS FOR COAL.

THE Gas Committee of the above are prepared to receive TENDERS for the supply of the whole or part of 10,500 Tons of Best Screened GAS COAL, to be delivered at Loughborough Station, at such times and in such quantities as may be required during the Year from July 1, 1900, to June 30, 1901.

Tenders to be addressed to the undersigned, and to be delivered not later than Monday, the 14th day of May, 1900.

The Committee do not bind themselves to accept the lowest or any Tender, and reserve themselves the power to accept a portion of a Tender.

By order,
EDWARD ONIONS,
Engineer and Manager.

CORPORATION OF LOUGHBOROUGH.

TENDERS FOR TAR AND AMMONIACAL LIQUOR.

THE Gas Committee invite Tenders for their surplus TAR and AMMONIACAL LIQUOR for Twelve Months from July 1, 1900, to June 30, 1901.

Estimated amount of Tar 600 Tons, and Water 950 Tons.

The Contractor to state price for Water at 5° Twaddel, and per ton extra for every 1° above 5°

The Corporation to deliver both Tar and Water into Contractor's Boats at the Derby Road Wharf, Loughborough.

The Committee do not bind themselves to accept the highest or any Tender.

Tenders to be signed and endorsed "Tender for Tar," and delivered to the undersigned at the Gas Office, Loughborough, by Monday, May 14, 1900.

By order,
EDWARD ONIONS,
Engineer and Manager.

BOROUGH OF BURTON-UPON-TRENT.

TO COLLIERY PROPRIETORS.

THE Mayor, Aldermen, and Burgesses of the Borough of Burton-upon-Trent, acting by the Council, are prepared to receive TENDERS from Colliery Proprietors for the supply of 30 000 Tons of best screened GAS COAL or NUTS, and 5000 Tons of CANNEL, or portions thereof.

Forms of Tender and Conditions of Supply may be obtained upon application at my Office; and sealed Tenders, endorsed "Coal," are to be delivered to me at or before Ten a.m., on Monday, the 28th day of May inst.

The Council do not bind themselves to accept the lowest or any Tender.

F. L. RAMSDEN,
Manager and Engineer.

The Gas and Electric Light Works,
Wetmore Road, Burton-upon-Trent,
May 2, 1900.

BOROUGH OF BURTON-UPON-TRENT.

LIME.

THE Mayor, Aldermen, and Burgesses of the Borough of Burton-upon-Trent, acting by the Council, are prepared to receive TENDERS for about 400 Tons of best Hand-Picked LIME for Purifying, to be delivered in Senders' or Railway Company's Trucks at the Gas-Works Railway Siding, Burton-upon-Trent, between the 1st day of July next and the 30th day of June, 1901.

The deliveries are to be made in such quantities and at such times as may be required by the Manager.

Payment: Net Cash monthly.

Tenders, endorsed "Lime," are to be delivered to me at or before Ten a.m., on Monday, the 28th day of May inst.

The Council do not bind themselves to accept the lowest or any Tender.

F. L. RAMSDEN,
Manager and Engineer.

Gas and Electric Light Works,
Wetmore Road, Burton-upon-Trent,
May 2, 1900.

TO COLLIERY PROPRIETORS AND OTHERS.

THE Leek Urban District Council invite TENDERS for the supply of Best Screened GAS COAL, Washed NUTS, and CANNEL for One Year from the 1st of July, 1900, to be delivered at the Leek Station on the North Staffordshire Railway at such times and in such quantities as may be required.

Further Particulars and Forms of Tender may be obtained from the undersigned.

Sealed and endorsed Tenders, addressed to the Chairman of the Gas Committee, to be delivered at the Town Hall, Leek, not later than Saturday, the 12th of May, 1900.

By order,
C. HENSHAW,
Clerk of the Council.

Town Hall, Leek,
April 28, 1900.

SKIPTON URBAN DISTRICT COUNCIL.

TO COLLIERY PROPRIETORS, COAL MERCHANTS, AND OTHERS.

THE Council invite Tenders for the supply of about 8500 Tons of Best Screened GAS COAL, to be delivered free at the Railway Station at Skipton, or at the Council's Siding adjoining the Gas-Works on the Leeds and Liverpool Canal, between July 1, 1900, and July 1, 1901, in monthly quantities.

No Form of Tender issued.

Further Particulars as to periods and quantities of Deliveries, &c., may be obtained from the Manager, Mr. J. H. Woodward, Gas-Works, Skipton; and Tenders, endorsed "Tender for Gas Coal," are to be sent to him on or before Saturday, May 12, 1900.

The lowest or any Tender not necessarily accepted.

RICHARD WILSON,
Clerk to the Council.

April 27, 1900.

MARSDEN URBAN DISTRICT COUNCIL.

THE Gas Committee are prepared to receive TENDERS for the supply of 2000 Tons of GAS SLACK, between the 1st of July, 1900, and June 30, 1901, to be delivered free at the Marsden (L. & N. W.) Station, in such quantities as the Manager may direct.

Tenders, stating Price per ton in Colliery and Council's Waggons, to be sent in on or before Thursday, the 17th of May, 1900, and endorsed on the outside, "Coal."

The Gas Committee do not bind themselves to accept the lowest or any Tender.

ARTHUR HALLIWELL,
Secretary and Manager.

Gas-Works, Marsden,
May 1, 1900.

NEW MILLS URBAN DISTRICT COUNCIL.

TENDERS FOR GAS COAL, &c.

THE New Mills Urban District Council invite TENDERS for the supply of 1600 Tons of best GAS COAL and 300 Tons of CANNEL for the Year ending June 30, 1901.

Form of Tender and full Particulars may be had on application to the Gas Manager.

Tenders to be sent in to me, the undersigned, not later than the 16th of May, 1900.

TENDERS are also invited for the purchase of surplus TAR and LIQUOR for One Year ending June 30, 1901.

The Council do not bind themselves to accept the lowest or any Tender.

JOSEPH POLLITT,
Clerk.

Town Hall, New Mills,
April 30, 1900.

BOROUGH OF DARWEN.

TENDERS FOR GAS COAL.

THE Corporation are prepared to receive TENDERS for the supply of GAS COAL, for One, Two, or Three Years, to be delivered at the Gas-Works Siding in the Corporation Waggons.

Forms of Tender and all Information as to quantities may be obtained on application to Mr. A. H. Smith, Gas Engineer, Darwen.

Sealed Tenders, endorsed "Gas Coal," must be delivered to the undersigned at or before noon, Saturday, May 26, 1900.

No Tender necessarily accepted.

By order,
CHAS. COSTEKER,
Town Clerk.

Town Clerk's Office, Darwen.
May 2, 1900.

BOROUGH OF DARWEN.

THE Corporation are prepared to receive TENDERS for all the surplus GAS TAR produced at their Gas-Works for One Year.

Also for the supply of the following Goods for One Year:—

(1) OILS and PAINTS.
(2) VITRIOL.
(3) WROUGHT-IRON TUBES and FITTINGS.
(4) CAST-IRON MAINS and SPECIALS.
(5) LEAD PIPE.

Particulars as to Quantities may be obtained on application to Mr. A. H. Smith, Gas Engineer, Darwen.

Sealed and endorsed Tenders must be delivered to the undersigned at or before noon, Saturday, May 26, 1900.

No Tender necessarily accepted.

By order,
CHAS. COSTEKER,
Town Clerk.

Town Clerk's Office, Darwen,
May 2, 1900.

TENDERS FOR GAS COAL.

THE Directors of the Blyth and Cowpen Gas Company invite TENDERS for the supply of good unscreened GAS COALS as may be required for a period of Six or Twelve Months from the 1st day of August, 1900. The quantity required over the Twelve Months being approximately 6000 Tons, the greater half of this quantity will be taken over the first Six Months.

The Directors desire quotations for the two periods named, and reserve the right to divide the quantity between two or more Firms.

The Coals must be delivered f.o.r. at the Gas-Works Siding, Blyth, in such quantities and at such times as the Gas Manager may direct.

Sealed Tenders, addressed to the undersigned, and endorsed "Tender for Gas Coals," are to be sent in on or before the 16th of May, 1900.

ANDREW C. FAWCETT,
Secretary.

Gas Offices, Waterloo, Blyth,
Northumberland, April 30, 1900.

*** A recent Analysis of the Coals intended to be supplied will be acceptable.

TENDERS FOR GAS COALS.

THE Brentwood Gas, Coke, and Light Company, Limited, invite TENDERS for the supply of about 4500 Tons of DURHAM or Best Unscreened SILKSTONE GAS COALS, to be delivered in Trucks at Brentwood Railway Station (G.E.R.) during the period of Nine Months between June 1, 1900, and Feb. 28, 1901, in quantities from time to time as required.

The Directors reserve the right to accept Tenders for the whole or any portion of the quantity offered, and do not bind themselves to accept the lowest or any Tender.

Tenders, with Analysis of the Coal, to be supplied and Terms for monthly payments to be sent to the undersigned on or before the 21st inst. Payment will only be made on the quantities delivered over the Weigh-bridge belonging to the Great Eastern Railway Company at this Station.

Forms of Tender not supplied.

C. A. FIELDER,
Secretary.

Brentwood, Essex.,
May 4, 1900.

NEWTON-IN-MAKERFIELD URBAN DISTRICT COUNCIL.

TENDERS FOR COAL AND CANNEL.

THE Urban District Council of Newton- in-Makerfield invite TENDERS for the supply of GAS COAL and CANNEL, as may be required at their Gas-Works for a period of One Year from June 1, 1900, to May 31, 1901, to be delivered at Earlestown Railway Station (L. & N.W.), free of carriage.

Form of Tender may be obtained from the undersigned.

Tenders, endorsed "Gas Coal" or "Cannel," addressed to the Chairman of the Gas Committee, to be delivered at my Office not later than the 19th of May, 1900.

The Council do not bind themselves to accept the lowest or any Tender.

W. W. SHIRLEY,
Clerk to the Council.

Clerk's Office, Town Hall, Earlestown,
May 3, 1900.

BOROUGH OF SMETHWICK.

THE Gas Committee invite Tenders for PAINTING GASHOLDERS, PURIFIERS, and other IRONWORK at their Gas-Works situated at Rabone Lane, Smethwick, in accordance with the Specification, copy of which may be obtained on application to Mr. B. W. Smith, at the Gas-Works.

Separate Tenders will be required (*a*) for Paint only, mixed ready for using, and (*b*) for providing the Labour and necessary Tools and Plant for execution of the Work.

Contractors will be required to pay the Standard Rates of Wages recognized in the District.

Tenders, endorsed "Tender for Painting," addressed to the Chairman of the Gas Committee, to be delivered to the undersigned not later than the 24th of May next.

The Committee do not bind themselves to accept the lowest or any Tender.

By order
(Signed) W. J. STURGES,
Secretary.

Gas Offices, Town Hall,
Smethwick.

THE Corporation of the City of Bangor are prepared to receive TENDERS for the GAS COAL required at their Gas-Works during the ensuing Year, in such quantities and at such times as may be required (in all 4000 Tons) from the 1st of August, 1900, to the 31st of July, 1901.

The person whose tender is accepted will be required to enter into an Agreement with the Council for the due performance of his contract.

The lowest or any Tender not necessarily accepted.

The Council also reserve the right to divide the contract between two or more Contractors.

Further Information and Forms on which the Tenders must be made may be obtained on application to the undersigned.

Sealed Tenders, addressed to the Chairman of the Lighting Committee, must be delivered on or before the 24th of May.

JOHN SMITH,
Manager.

Gas-Works, Bangor,
May 2, 1900.

COWES URBAN DISTRICT COUNCIL.

(GAS DEPARTMENT.)

THE Gas Committee of the above are prepared to receive TENDERS for the supply of the whole or part of 4000 Tons of best screened GAS COAL, to be delivered f.o.b. in quantities as may be required during the Year ending May 31, 1901. Four days allowed for loading at port of shipment.

Tenderers may at their option give an alternative price including delivery in Sailing Ships, not exceeding 13 ft. 6 in. extreme draft, at the Gas Department's Wharf at Cowes, or in Sailing Ships or Steam Ships at the Railway Company's Wharf at Cowes.

The Committee reserve the right to accept Tenders for the whole or any portion of the quantity offered, and do not bind themselves to accept the lowest or any Tender.

Any further Particulars may be obtained of the undersigned.

Sealed Tenders, endorsed "Tender for Coal," to be delivered at the Offices of the Department not later than the 14th day of May next.

By order,
WILLIAM HALLIDAY,
Secretary.

Gas Offices, 40, High Street,
Cowes, April 25, 1900.

MANSFIELD CORPORATION.

(GAS DEPARTMENT.)

TENDERS FOR GAS COAL AND CANNEL.

TENDERS FOR TAR AND AMMONIACAL LIQUOR.

COAL.

THE Gas Committee are prepared to receive TENDERS for 2000 Tons of CANNEL and 8000 Tons of best screened GAS COAL, delivered at Mansfield Station, for One Year from the 1st of June, 1900, to the 31st of May, 1901.

TAR AND LIQUOR.

Tenders for surplus TAR and LIQUOR made during the Year, from the 1st of July, 1900, to the 30th of June, 1901. Tenders for Liquor to be made either at a fixed price per Ton or on the Sliding-Scale regulated by the price of Sulphate.

Tenders, endorsed "Coals," to be sent to J. Harrop White, Esq., Deputy Town Clerk, Mansfield, on or before the 25th of May, 1900.

Particulars and all other Information from the undersigned.

No special Form of Tender provided.

The Committee do not bind themselves to accept the lowest or any Tender.

ARTHUR GRAHAM,
Engineer and Manager.

Gas-Works, Mansfield,
May 2, 1900.

BOROUGH OF EVESHAM.

(Gas Department.)

THE Town Council are prepared to receive TENDERS for the supply of from 500 to 2000 Tons of Best Screened GAS COAL, to be delivered at one of the Evesham Railway Stations between July 1, 1900, and June 30, 1901.

Tenders, to be endorsed "Tender for Coal," and delivered to the undersigned on or before the 4th of June next. No Forms of Tender supplied.

The Council do not bind themselves to accept the lowest or any Tender.

Thos. Cox,
Town Clerk.

Evesham, May 2, 1900.

DENTON URBAN DISTRICT COUNCIL.

(Gas Department.)

TAR.

THE Gas Committee invite Tenders for TAR, the same to be sent in on or before the 16th of May inst.

Particulars may be obtained from the Gas Engineer, Mr. J. Chadwick Smith, Gas-Works, Denton, near Manchester.

The Committee do not bind themselves to accept the highest or any Tender.

By order,
Wm. Richards,
Clerk to the Council.

May 1, 1900.

TO COLLIERY PROPRIETORS.

THE Directors of the Sheffield United Gaslight Company invite TENDERS for GAS COAL, NUTS, and CANNEL, for delivery during Twelve Months to the 30th of June, 1901.

The quantities required will be approximately—

100,000 Tons of Gas Coal (Tenders to state whether Screened or Unscreened).
100,000 Tons of Nuts.
60,000 Tons of Cannel.

Tenders (Forms for which can be obtained on application) must be delivered to the undersigned, by post, not later than the first post on Friday, May 11.

The Directors reserve the right to take the whole or any portion of the quantity offered, and do not bind themselves to accept the lowest or any Tender.

Hanbury Thomas,
General Manager and Secretary.

Commercial Street, Sheffield,
April 27, 1900.

SHREWSBURY GASLIGHT COMPANY.

TENDERS FOR COAL.

THE Directors of the Shrewsbury Gaslight Company, invite TENDERS for the supply of about 15,500 Tons of screened GAS COALS, to be delivered free at the Great Western or London and North-Western Goods Yard, Shrewsbury, during the Year commencing July 1, 1900, and ending June 30, 1901.

The Directors reserve to themselves the right to divide the quantity into two or more Contracts, and do not bind themselves to accept the lowest or any Tender.

Tenders must be made on Forms (containing further Particulars), which may be obtained on application at the Company's Works, or by post, and must be sent to the undersigned, on or before the 24th day of May, 1900.

By order,
Wm. Belton, Assoc.M.Inst.C.E.,
Secretary and Manager.

Gas-Works, Shrewsbury,
April 28, 1900.

COUNTY BOROUGH OF HALIFAX.

TO ENGINEERING CONTRACTORS.

THE Gas-Works Committee invite TENDERS for the supply and erection of STEEL GIRDERS, BUCKSTAVES, &c., required for their New Retort-Benches.

Forms of Tender, Specification, and Prints may be obtained on application to Mr. Thomas Holgate, M.Inst.C.E., Gas Engineer, Halifax, on payment of £1, which will be returned on the receipt of a *bonâ-fide* Tender.

Sealed Tenders, endorsed "Retort-Benches," must be sent to the undersigned before Ten o'clock a.m., on Wednesday, the 16th of May, 1900.

The person whose Tender is accepted will be required to observe the Fair Contracts Clauses adopted by the Corporation.

The Committee do not bind themselves to accept the lowest or any Tender.

By order,
Keighley Walton,
Town Clerk.

BRIDGNORTH CORPORATION GAS-WORKS.

TO COLLIERY PROPRIETORS AND OTHERS.

THE Gas Committee are prepared to receive sealed TENDERS for the supply of GAS COAL, including carriage to the Bridgnorth Railway Station, for One Year from or soon after the end of June next.

Evidence as to quality of Coal must accompany each Tender.

Quantity required: About 2500 Tons per annum in proportionate deliveries as directed—say 70 per cent. during Winter Months, and 30 per cent. during Summer Months.

Sealed and marked Tenders must be sent to the undersigned not later than Monday, the 14th of May.

The Committee reserve to themselves the right to divide the quantity into two or more Contracts, and do not bind themselves to accept the lowest or any Tender.

Official Forms of Tender are not furnished.

By order,
J. H. Cooksey, Town Clerk,
Secretary.

Bridgnorth, April 28, 1900.

CORPORATION OF MANCHESTER.

TENDERS FOR COAL AND CANNEL.

THE Gas Committee are prepared to receive, on or before Monday, the 14th of May next, OFFERS of high class CANNELS and COALS suitable for Gas Making, for delivery at their Gaythorn, Rochdale Road, and Bradford Road Works, during a period of One, Two, or Three Years, commencing the 1st of August, 1900.

Particulars and printed Forms of Tender may be obtained on application (in writing only) to Mr. Charles Nickson, Superintendent, Gas Department, Town Hall, Manchester.

By order of the Gas Committee.
Wm. Henry Talbot,
Town Clerk.

Town Hall, Manchester,
April 27, 1900.

BOROUGH OF DONCASTER.

TENDERS FOR COAL.

THE Gas Committee of the Borough of Doncaster are prepared to receive TENDERS for the supply of 24,000 Tons of best screened GAS COAL, during a period commencing July 1, 1900, and terminating June 30, 1901.

Particulars and Tender Forms may be obtained on application to the Chairman, or to the undersigned.

Tenders should be sent, under seal, to the Chairman, endorsed "Tender for Coal," not later than Ten a.m. on Thursday, May 10 next.

By order of the Gas Committee, who do not bind themselves to accept the lowest or any Tender.

R. Bridge,
Engineer.

Gas-Works, Doncaster,
April 25, 1900.

BOROUGH OF BARROW-IN-FURNESS.

TENDERS FOR COAL AND CANNEL.

THE Corporation are prepared to receive TENDERS for the supply of screened GAS COAL AND CANNEL during the Year ending the 30th of June, 1901.

Form of Tender and further Particulars may be obtained from the Manager of the Gas-Works.

Tenders, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Coal," to be delivered at the Town Clerk's Office not later than Twelve o'clock noon on Wednesday, the 23rd day of May, 1900.

The lowest or any Tender not necessarily accepted.

By order,
C. F. Preston,
Town Clerk.

Town Hall, Barrow-in-Furness,
April 26, 1900.

THE URBAN DISTRICT COUNCIL OF STOURBRIDGE.

(Gas Department.)

THE Gas Committee invite Tenders for the supply and delivery of about 15,000 Tons of GAS COAL.

Form of Tender, &c., may be had on application to the undersigned, at the Gas-Works.

Tenders, endorsed "Gas Coal," to be addressed to the Chairman of the Gas Committee, and sent to me at the Gas-Works before Twelve o'clock on Wednesday, the 16th day of May, 1900.

The lowest or any Tender not necessarily accepted.

By order,
W. North,
Engineer and Manager.

Gas-Works, Stourbridge,
May 4, 1900.

CORPORATION OF LEICESTER.

CAST-IRON TANKS.

THE Gas and Electric Lighting Committee of the above Corporation are prepared to receive TENDERS for the supply and erection of two CAST-IRON TANKS, one 30 ft. diameter by 9 ft. deep, and one 12 ft. diameter by 9 ft. deep at their Aylestone Road Works.

Drawings may be seen, and Specification and Form of Tender obtained, upon application to the Engineer, and on payment of the sum of £5, which amount will be returned upon receipt of a *bonâ-fide* Tender.

Tenders, addressed to Alderman Lennard, J.P., Chairman, and endorsed "Tender for Cast-Iron Tanks," to be delivered at these Offices not later than Eleven o'clock, a.m., on Saturday, May 12.

The Committee do not bind themselves to accept the lowest or any Tender.

Alfred Colson, M.Inst.C.E.,
Engineer and Manager.

Offices: Millstone Lane, Leicester.,
May 1, 1900.

CORPORATION OF LEICESTER.

LANCASHIRE BOILERS.

THE Gas and Electric Lighting Committee of the above Corporation are prepared to receive TENDERS for the supply and erection, on Foundations provided, of two LANCASHIRE BOILERS, 20 ft. by 6 ft. 6 in., at their Belgrave Gate Works.

Specification and Form of Tender may be obtained upon application to the Engineer, and upon payment of the sum of £5, which amount will be returned upon receipt of a *bonâ-fide* Tender.

Tenders, addressed to Alderman Lennard, J.P., Chairman, and endorsed "Tender for Boilers," to be delivered at these Offices, not later than Eleven o'clock, a.m., on Saturday, May 12.

The Committee do not bind themselves to accept the lowest or any Tender.

Alfred Colson, M.Inst.C.E.,
Engineer and Manager.

Offices: Millstone Lane, Leicester,
May 1, 1900.

THE Directors of the Colwyn Bay and District Gas Company invite TENDERS for the supply of from 3500 to 4000 Tons of screened GAS COAL, to be delivered free at Colwyn Bay Station during the Twelve Months ending June 30, 1901.

Tenders to be sent in not later than May 18, 1900, to William Earp, Esq., Chairman of the Gas Company.

J. C. Pennington.

BOROUGH OF CHORLEY.

TO COLLIERY OWNERS AND OTHERS.

THE Chorley Corporation invite TENDERS for the supply of GAS COAL, CANNEL, and CANNEL CHIPPINGS required at their Gas-Works during a period of Twelve Months commencing the 1st of July next.

Forms of Tender and any further Information may be obtained on application to Mr. John M'Cubbin, Gas Manager, Chorley.

Tenders, endorsed "Coal," to be sent to me on or before Tuesday, the 22nd inst.

The Corporation do not bind themselves to accept any Tender.

By order,
Jno. Mills,
Town Clerk.

Town Hall, Chorley,
May 4, 1900.

CITY OF LEEDS.

(Gas Department.)

TENDERS required as below:—

For CRAVEN or DERBYSHIRE LIME.
For WROUGHT-IRON TUBES.
For COMPRESSED and COMMON RED BRICKS
For 2½-inch, 3-inch, and 4-inch Self-Faced BRADFORD or HALIFAX FLAGS.

Forms of Tender may be obtained on application to the undersigned.

Endorsed Tenders, addressed to the Chairman of the Gas Committee, Municipal Buildings, Leeds, will be received not later than Tuesday, the 22nd inst.

The Committee do not bind themselves to accept the lowest or any Tender.

R. H. Townsley,
General Manager.

Municipal Buildings, Leeds,
May 5, 1900.

THE NORTHWICH GAS COMPANY.

Incorporated by Act of Parliament, 1882.

DIRECTORS.

Mr. George Barlow Cliff, J.P., Moss Cliffe.
Mr. Joseph Barlow, Davenham.
Mr. John Clough, J.P., Northwich.
Mr. William Hesketh, Lostock.
Mr. John Moreton, Pickmere.
Mr. James Rogerson, Hartford.

Manager—Mr. S. S. Mellor.
Secretary—Mr. H. Pickering.

ISSUE OF ADDITIONAL CAPITAL.

600 PREFERENCE SHARES

Of £10 each, to bear a Preferential Dividend of £4 per cent. per annum.

PARR'S Banking Company, Limited, are authorized by the Northwich Gas Company to received TENDERS at their Branch, the Old Bank, Northwich, for 600 PREFERENCE SHARES of £10 each, with Preferential Dividend at 4 per cent. per annum, free of Income-Tax.

The Dividends of the Company are declared half-yearly, as early as possible after the Half-Yearly Meetings, usually held in February and August.

The present issue of Additional Capital is for the purpose of making additions to the Working Plant of the Company, which are rendered necessary by the increase in the consumption of Gas in the Company's district.

The present Capital of the Company consists of £24,000 in 1600 fully-paid-up £15 shares, £8000 in Four per Cent. Preference Shares, and in addition £8000 has been raised by a mortgage of the Company's Undertaking under the power contained in their Act of Incorporation. The Company have power by their Act to raise further Sums on Mortgage.

The Dividend on the present issue will be a first charge on the Net Profits of the Undertaking after payment of Interest on the authorized Mortgages, and will rank equally with the Preference Shares already issued.

The average Dividends of the Undertaking on the Ordinary Shares since the Company was incorporated have been 8 per cent.

Tenders, on form accompanying Prospectus, with the required Deposit, must be delivered at Parr's Banking Company, Limited, Northwich, on or before Twelve o'clock on Saturday, the 12th of May next; and they will be opened on that day at the Offices of the Company, in Northwich, in the presence of a quorum of the Directors of the Company.

Tenders must be enclosed in a sealed envelope endorsed "Northwich Gas Company. Tender for Preference Shares."

Applications must be accompanied by a Deposit of 10 per cent. on the amount tendered for.

Where no allotment is made, the Deposit will be returned in full, and in case of a partial allotment, the balance of the Deposit will be applied towards the payment in respect of the allotment; the balance, if any, being returned to the subscriber. If default be made in payment of any Instalment at its proper date, the Deposit and Instalments previously paid will be liable to forfeiture.

Share Certificates will be issued in exchange for allotment Letters and Bankers' receipts for the Deposit and Instalments.

Payment for the Shares will be by the following Instalments:—

On application, £1 per share.
On the 9th of June, 1900, £4 per Share.
And the balance on the 30th of June, 1900.

The Dividend will run from the 1st of July, 1900. No Tender will be accepted at less than £10 per Share.

Tenders must be on the Printed Form which, with the Prospectus, can be obtained at Parr's Banking Company, Limited, Northwich, and from Mr. Henry Pickering, Secretary, The Gas-Works, Northwich.

The Gas Company's Office, Northwich,
April 20, 1900.

ST. IVES (HUNTS) GAS COMPANY, LIMITED.

THE Directors of the above Company are prepared to receive TENDERS for the supply of 800 to 1000 Tons of good GAS COAL during the next Twelve Months, delivered at St. Ives.

Tenders to be sent to the Secretary, No. 1, Welford Road, Leicester, not later than May 25, 1900.

H. W. WILSHERE,
Secretary.

May 4, 1900.

OAKHAM GAS COMPANY, LIMITED.

THE Directors of the above Company are prepared to receive TENDERS for the supply of 1100 Tons of good screened GAS COAL.

For Particulars and Form of Tender, apply to the undersigned.

Sealed and endorsed Tenders to be addressed to the Chairman of the Company not later than May 25, 1900.

JAS. MASON,
Manager.

May 4, 1900.

COUNTY BOROUGH OF SALFORD.
(GAS DEPARTMENT.)

TENDERS FOR COAL AND CANNEL.

THE Gas Committee invite Tenders for the supply of COAL and CANNEL required at their Works during a period of One Year.

Forms of Tender may be obtained on application to the Gas Engineer, Gas Offices, Bloom Street, Salford.

Sealed Tenders, endorsed "Tender for Coal," addressed to the Chairman of the Gas Committee, to be delivered to me not later than Three p.m. on Thursday, the 17th of May, 1900.

L. C. EVANS,
Town Clerk.

Town Hall, Salford,
May 4, 1900.

ULVERSTON URBAN DISTRICT COUNCIL.

TENDERS FOR COAL AND CANNEL.

THE Gas and Water Committee invite TENDERS for the supply of Best Screened GAS COAL AND CANNEL for One, Two, or Three Years, commencing the 1st of July next.

Parties tendering must give full Particulars of the Coal and Cannel they propose to supply, and name the Pit from which the same will be raised.

Further Information and Forms of Tender may be obtained on application to the undersigned.

Sealed Tenders to be sent in not later than the 31st inst., addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Coal or Cannel."

The Committee do not bind themselves to accept the lowest or any Tender.

JNO. SWAN,
Engineer and Manager.

IMPERIAL CONTINENTAL GAS ASSOCIATION.
(INCORPORATED BY ACT OF PARLIAMENT.)

NOTICE is Hereby Given, that the HALF-YEARLY ORDINARY GENERAL MEETING of the Proprietors of this Association was held at the City Terminus Hotel, Cannon Street, London, E.C., on Tuesday, the 1st inst.,

THOMAS HENRY GOODWIN NEWTON, Esq., in the Chair, when the following RESOLUTIONS were unanimously passed:—

"That the Report of the Directors upon the affairs of the Association be received, adopted, and entered upon the Minutes."

"That a Dividend of 5 per cent. for the Half Year ended the 31st of December last be declared upon the £8,800,000 Capital Stock of the Association, and that the same be payable, free of Income-Tax, on and after the 8th of May next."

"That Sir Charles James Jessel, Bart., be re-elected a Director of the Association."

"That John Henry Birchenough, Esq., be re-elected a Director of the Association."

"That Sir James Morse Carmichael, Bart., be re-elected a Director of the Association."

"That Montagu Somes Pilcher, Esq., be re-elected an Auditor of the Association."

Votes of Thanks were passed to the Directors for their able management of the affairs of the Association, to the Chairman for his conduct in the Chair, and to the Staff in London and on the Continent.

By order of the Board,
ROBERT W. WILSON,
Secretary.

21, Austin Friars, London, E.C.,
May 2, 1900.

By order of the Directors of the
HIGH WYCOMBE GAS COMPANY.

ISSUE OF 1000 £5 ADDITIONAL SHARES.

MR. C. H. ELSOM will sell the above by AUCTION at the Guildhall, High Wycombe, Bucks, on Friday, May 18, 1900, at Three o'clock, in Lots.

Particulars of the SECRETARY of the Company, and of the AUCTIONEER, Church Street, HIGH WYCOMBE.

HARROGATE GAS COMPANY.

SALE BY TENDER OF £10,000 FOUR PER CENT. PREFERENCE STOCK.

THE Directors of this Company are prepared to receive TENDERS for the Whole or any portion, not being less than £10 or a multiple thereof, of the above-named £10,000 FOUR PER CENT. PREFERENCE STOCK.

Particulars of the same, with Form of Tender, can be obtained at this Office on application to the undersigned.

Tenders to be sent in not later than Twelve o'clock noon on Thursday, the 24th day of May, 1900.

By order,
H. WILKINSON,
Secretary and General Manager.

Gas Offices, Harrogate,
April 27, 1900.

CROYDON COMMERCIAL GAS AND COKE COMPANY.

MR. GODFREY C. LAMBERT has received Instructions to SELL BY AUCTION, at the Greyhound Hotel, Croydon, on Thursday, May 17, 1900, at Six o'clock precisely, £65 CONSOLIDATED "A" STOCK and £25 CONSOLIDATED "B" STOCK of the Croydon Commercial Gas and Coke Company, producing Dividends at the rate of 14 per cent. and 11 per cent. respectively.

Particulars and Conditions of Sale may be had of the AUCTIONEER, 10, BASINGHALL STREET, E.C.

SALES BY AUCTION OF GAS AND WATER STOCKS AND SHARES.

MR. ALFRED RICHARDS begs to notify that his AUCTIONS of STOCKS and SHARES in London, Suburban, and Provincial Gas and Water Companies are held PERIODICALLY, at the Mart, Tokenhouse Yard, E.C.

He also undertakes the issuing by AUCTION of GAS and WATER STOCKS and SHARES under Parliamentary Powers.

Terms for issuing such Capital, and also for including Gas and Water Stocks and Shares in these periodical Sales, can be obtained on application at Mr. ALFRED RICHARDS' OFFICES, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
PLYMOUTH AND STONEHOUSE GAS COMPANY.

NEW ISSUE OF £4500 ORDINARY STOCK.

MR. ALFRED RICHARDS will Sell THE ABOVE BY AUCTION, at the Mart, E.C., on Wednesday, May 23, at Two o'clock, in Lots.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Executors of the late W. H. H. Broadberry, Esq.

MR. ALFRED RICHARDS will Sell BY AUCTION, at the Mart, E.C., on Wednesday, May 23, at Two o'clock,

GAS AND WATER STOCKS AND SHARES
OF THE
TOTAL CAPITAL VALUE OF ABOUT £4000,
IN THE

Tottenham and Edmonton Gas Company, Southend Gas Company, West Surrey Water Company, Barnet District Gas and Water Company, Romford Gas and Coke Company, Horley District Gas Company, Woking Water and Gas Company, Harrow and Stanmore Gas Company, Waltham Abbey and Cheshunt Gas Company, Colney Hatch Gas Company, Buntingford Gas Company, St. Margaret's Gas Company, and the South African Lighting Association.

Particulars of the AUCTIONEER, 18, FINSBURY CIRCUS, E.C.

By order of the Directors of the
CRAWLEY GAS COMPANY, LIMITED.

THE FREEHOLD GAS-WORKS SITUATE AT CRAWLEY, SUSSEX.

Conveniently placed close to the Main Road, within about half-a-mile of Crawley Station on the London, Brighton, and South-Coast Railway, and comprising Retort-House (with Nine Retorts), Two Gasholders, Purifiers, Scrubber, Coal-Store, Lime-Shed, Tar-Well, Meter and Governor House, Manager's House, together with the Mains to a length of about 3½ miles, Meters, Services, and Tools. The whole to be sold as a going concern, and with possession on completion.

MR. ALFRED RICHARDS will Sell THE ABOVE BY AUCTION, at the Mart, Tokenhouse Yard, E.C., on Tuesday, June 12, 1900, at Two o'clock, instead of May 23, as previously announced.

Particulars of the SECRETARY of the Company, at the Offices, High Street, CRAWLEY; of Messrs. HOLMES, LEAB, AND BELDAM, Solicitors, ARUNDEL; and of Mr. ALFRED RICHARDS, Auctioneer, 18, FINSBURY CIRCUS, E.C.

UNEQUALLED.

Gas Companies are solicited to try Samples of the

MIRFIELD
BLACK BED GAS COAL.

Prices and Analysis on application.

MIRFIELD (GAS-COAL) COLLIERY COMPY.
RAVENSTHORPE, NEAR DEWSBURY.

HEATHCOTE GAS COAL.

Rich in Illuminating Power and Yield of Gas.

Above the Average in Weight and Quality of Coke.

Maintains a High Standard in Residuals.

THE GRASSMOOR CO., LD.,
CHESTERFIELD.

NEWBATTLE CANNEL.

Highest Results in Gas, & Excellent Coke.

QUOTATIONS ON APPLICATION TO

THE LOTHIAN COAL COMPANY,
LIMITED,
NEWBATTLE COLLIERIES,
DALKEITH N.B.

BOLDON GAS COALS.

Yield of Gas per Ton .	10,500	Cubic Feet.
Illuminating Power . .	16·9	Candles.
Coke	66·7	Coke.
Sulphur	0·86	Sulphur.
Ash	2·04	Ash.

As per Analysis by
Mr. JOHN PATTINSON, F.I.C., F.C.S.

For Prices, &c., apply to
W. H. PARKINSON,
THE HARTON COAL CO., LTD.,
NEWCASTLE-ON-TYNE.

Telegraphic Address: "PARKINSON, NEWCASTLE."

THORNLEY GAS COALS
WORKED BY THE
WEARDALE IRON & COAL Co., Ld.
OUT OF THEIR
THORNLEY AND WHEATLEY HILL COLLIERIES.

Analysis made by
Messrs. J. & H. S. PATTINSON.

Yield of Gas per Ton . .	10,500 Cub. Ft.
Illuminating Power . . .	16·9 Candles.
Coke (of good quality) . .	67·5 per Cent.
Sulphur	0·58 ,,
Ash	2·73 ,,

For Price, &c., apply to the
WEARDALE IRON & COAL Co., Ld.
QUAYSIDE, NEWCASTLE-ON-TYNE.

HOLMSIDE
GAS COALS.

Present Daily Produce over 5000 Tons.

Latest Analysis—By CHARLES PHILLIPS, Gas Examiner to Rotherham Corporation

Yield of Gas per Ton . . .	11,205 Cubic Feet.
Illuminating Power	16 7/10 Stand. Sperm. Candl.
Coke (of good & pure quality)	13¾ Cwt. per Ton.
Sulphur	A little over 1 per Cent.
Ash	Under 1 per Cent.
Tar	163 lbs. (Avoir.) per Ton.
Ammoniacal Liquor	103 lbs. (Avoir.) per Ton.

HOLMSIDE GAS COALS are supplied to the largest Gas Companies in England and on the European Continent; London alone consuming about half the produce.

SOUTH MOOR
PELTON GAS COALS.

Present Daily Produce available 3000 Tons.

Of equal quality to the "Holmside" Coal, and also very largely used by many Gas Companies at Home and Abroad.

Both descriptions are shipped at Tyne Docks, and Dunston Staiths, River Tyne, also at North and South Docks, Sunderland.

These Coals may be bought through the Principal Merchants in England, or direct from

MR. MARK ARCHER,
HOLMSIDE & SOUTH MOOR OFFICES,
NEWCASTLE-UPON-TYNE.

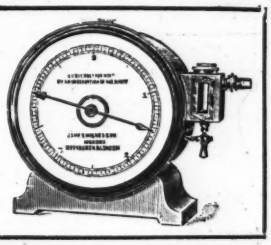
THOMAS DUXBURY & CO.,
16, DEANSGATE, MANCHESTER.
Best Gas Coal and Cannel, giving High Illuminating Power, Large Yield per ton, and reasonable in Price.
Telegrams: "DARWINIAN, MANCHESTER." Telephone 1806.

Price 6s., Cloth Bound,
THE CHEMISTRY OF ILLUMINATING GAS.
By N. H. HUMPHRYS, Assoc.M.Inst.C.E., F.C.S.
LONDON:
WALTER KING, 11, Bolt Court, FLEET STREET, E.C.

GAS PLANT New or 2nd Hand Equipments for Coal Gas, Water Gas, Oil, Acetylene, Coke Oven, and Blast Furnace Gas.
POWER or LIGHT WORKS.
Also VALUATION Consultation, Inspection & Expert Reports.
JAS. WRIGHT, M.I.M.E. BRIDGE HOUSE, BLACKFRIARS, E.C.

JUNKERS' CALORIMETER.
Sole Agent for the U.K. HERMANN KÜHNE, 25-35 NEW BROAD STREET, LONDON, E.C.

CARLESS, CAPEL & LEONARD,
HOPE CHEMICAL WORKS, HACKNEY WICK, LONDON, N.E.,
And at Pharos Works, Hackney Wick.
NAPHTHA AND GASOLINE DISTILLERS AND PETROLEUM IMPORTERS,
Specially distil Carburine Spirit, specific gravity ·680, or of any other grade suitable for Enriching Gas; also Gas Oil best adapted for injecting into the Retorts, as in the Herring Process.
Importers of Petroleum for Carburetting Water Gas, or for Manufacturing Oil Gas. Distillers of Pentane, Petroleum Ether, and Naphtha for clearing the pipes of Naphthaline, &c.
Samples and Prices may be had on application.

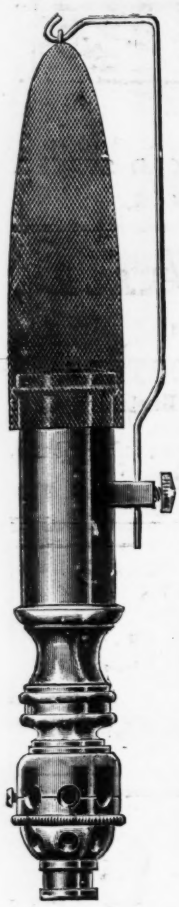
JAMES MILNE & SON, LTD.,
GAS ENGINEERS
MILTON HOUSE WORKS EDINBURGH.
LONDON. —— LEEDS. —— GLASGOW.


JAMES McKELVIE & Co.,
Cannel & Gas Coal Merchants,
HAYMARKET, EDINBURGH,
and 37 & 38, MARK LANE, E.C.

PRICES AND ANALYSIS
OF ALL THE PRINCIPAL
CANNEL AND GAS COALS
forwarded on Application.

ESTABLISHED 1840.

THE
INTENSIFIED GAS LIGHT COMPANY, LTD.



HIGH-PRESSURE PATENTS.

The only System actually giving over

300 CANDLES PER BURNER

Three Burners consuming 30 cubic feet per hour give a Light of 1000-Candle Power at half the cost of Electric Light.

Specially adapted for Lighting Railway Stations, Docks, Sheds, Workshops, Streets and Squares, Shop Windows, &c., &c.

Adopted by the L. & N.W. and Great Central Railways at their Euston and Marylebone Termini, Lancashire and Yorkshire Railway, the Crystal Palace, London Pavilion, Mersey and Leith Dock and Harbour Boards, Edinburgh and Leeds Gas Corporations; Messrs. Robinson's Ltd., Rochdale; the Brighton, Portsmouth, and Chester Gas Companies, &c., &c., &c.

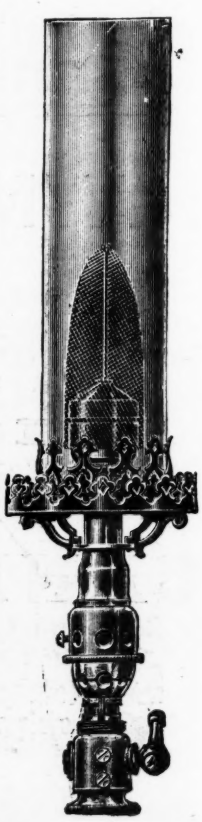
"The perfection of artificial lighting on the large scale."—"*Journal of Gas Lighting*," April 18, 1899.

ORDINARY GAS PRESSURE PATENTS.

The Intensified Company's improved Incandescent Burner, recently tested by direction of the Leeds Corporation Street Lighting Department, gave the following results:—

Gas.	Pressure.	Reading.	Standard.	Candles per Foot.
3·5	10/10	101·7	10·6	29·03
4·6	10/10	133·5	10·6	29·07

THE MOST EFFECTIVE AND ECONOMICAL BURNER on the market for both indoor and outdoor Lighting. Price complete 6s. 6d. MANTLES SUPPLIED TO THE COMPANY, FOR BOTH SYSTEMS, BY THE WELSBACH INCANDESCENT GAS-LIGHT COMPANY, UNDER LICENSE.



For full Particulars apply to the Company's Works:

3, Wilson Street, Drury Lane, London, W.C.

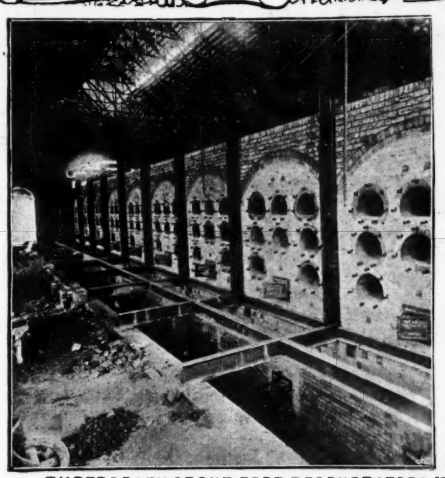
THE LEEDS FIRECLAY Co. LTD.

WORTLEY, LEEDS.

Engineering Department

RETORT SETTINGS

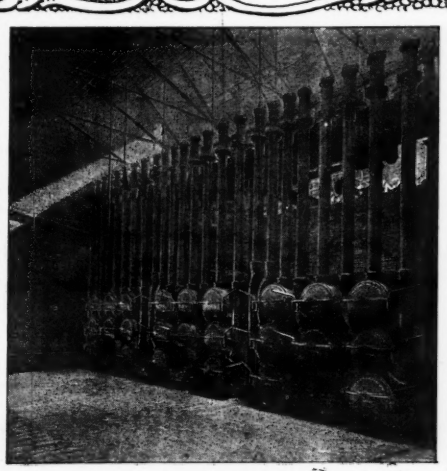
OF EVERY DESCRIPTION



PHOTOGRAPH OF OUR DEEP REGENERATORS DURING CONSTRUCTION.

Shallow REGENERATORS A SPECIALITY.

MANY INSTALLATIONS. EXCELLENT RESULTS OBTAINED.



PHOTOGRAPH OF OUR DEEP REGENERATORS AFTER COMPLETION.

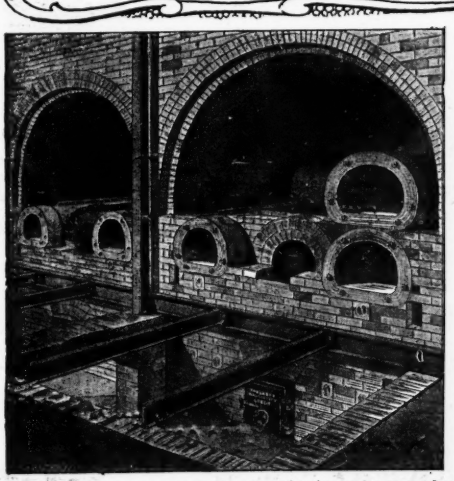
INCLINED AND HORIZONTAL REGENERATOR, GENERATOR, AND DIRECT FIRED.

RETORTS RE-SET.

RETORT IRONWORK

COAL & COKE BREAKING AND CONVEYING APPARATUS.

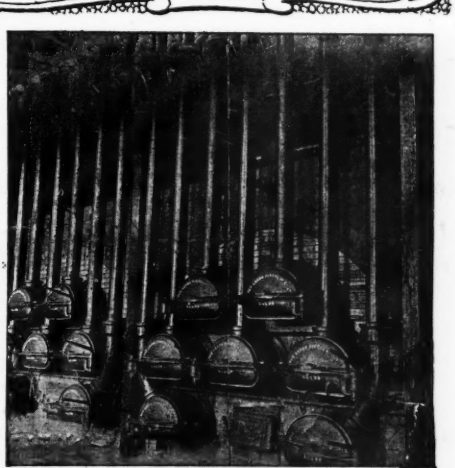
BUILDING ROOFS &c.



PHOTOGRAPH OF OUR SHALLOW REGENERATORS DURING CONSTRUCTION.

Telegrams "Settings" Leeds

Telephone No. 1332



PHOTOGRAPH OF OUR SHALLOW REGENERATORS AFTER COMPLETION.

WILSON CARTER & PEARSON,

GAS COAL AND CANNEL FACTORS,

Supply to any Railway Station, or for Export, all kinds of Fuel for Gas purposes.

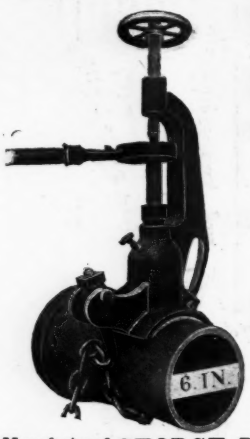
ADDRESS CHIEF OFFICES:

Temple Buildings, 50, New Street, Birmingham.

OSLER,

BIRMINGHAM.

MANUFACTURERS OF GASELIERS IN GLASS AND METAL.



TAPPING MACHINES

FOR

Drilling & Tapping

PIPE UNDER PRESSURE WITHOUT ANY ESCAPE OF GAS.

Combination Drills and Taps from ½ to 4 inches.

ADOPTED BY PRINCIPAL GAS COMPANIES THROUGHOUT THE UNITED STATES.

SEND FOR CATALOGUE.

Manufactured by GEORGE LIGHT, Dayton, OHIO, U.S.A.

THE THAMES BANK IRON CO.

UPPER GROUND STREET, LONDON, S.E.,

SUPPLY FROM STOCK

CAST-IRON RETORTS

AND ALL KINDS OF GAS-WORKS APPARATUS

SOCKET-PIPES FOR GAS OR WATER PURPOSES.

FLANGE PIPES FOR STEAM.

Sole Manufacturers of LYON'S "PATENT" GAS-MAIN SYPHONS.

AGENTS FOR

ATTERTON'S PATENT APPARATUS for CHARGING RETORTS.

BEST & LLOYD

Limited,

MAKERS OF THE **BIRMINGHAM.**

PATENT "SURPRISE" PENDANT,

WITH PATENT SHADE.

The ONLY GAS-PENDANT suitable for Domestic Lighting; a room 18 ft. by 14 ft. being beautifully illuminated with one Incandescent Burner.

Extract from the JOURNAL OF GAS LIGHTING, Jan. 8, 1895.

"IN CONJUNCTION WITH

THE INCANDESCENT GAS-LIGHT

it quite **supersedes** the familiar three-light pendent. We are able to bear witness to the **convenience** of the New Pendant.

INCLINED RETORTS

UP-TO-DATE FURNACES

AND SETTINGS.

J. & H. ROBUS, 20, Bucklersbury, London, E.C.

MOBBERLEY & PERRY

STOURBRIDGE.

Manufacture & supply best quality of

Gas Retorts (SEGMENTAL, HORIZONTAL, or INCLINED.)

Special Bricks & Blocks for GENERATOR & REGENERATOR FURNACES.

FIRE BRICKS, LUMPS, & TILES, BLUE STAFFORDSHIRE VITRIFIED BRICKS FOR PAVING, &c. &c.

EVERY REQUISITE FOR GAS-WORKS. Retort Setters sent to any part of the Kingdom.

London Agents: Contractors for the erection of Retort-Benches complete.

BALE & HARDY. Gas Engineers and Contractors, BRIDGE HOUSE, 181, QUEEN VICTORIA STREET, E.C.

H. GREENE & SONS, LTD.

Gas Engineers & Lighting Contractors.

THE "LONDON" CYLINDER LANTERN.

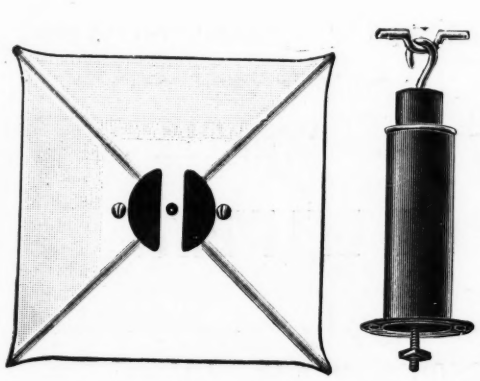
THE "BEACON" GLOBE LAMP.

As fitted at London Bridge near Railway Approach; three Lamps giving the Illuminating Power of 600 Candles. See Surveyor's Report as published in the "*JOURNAL*" for Jan. 10, 1899.

THE "PLYMOUTH" CYLINDER LANTERN.

The right-hand Illustration shows a 14-inch Lantern Fitted with Enamelled Deflector, &c. By using this simple adaptation, existing lamps with some further years of use in them are converted to a smart up-to-date Lantern; and, with the addition of the No. 2 or "C" Welsbach Burner, it supplies a much needed want with a very small outlay.

This adaptation divides the incoming cold air from the outgoing products of combustion, and forms the lamp into a double chamber lantern.



"TALBOT" DEFLECTOR AND CHIMNEY.

Made in two sizes, for 14 in. Lanterns and 16 in. Lanterns.

USED BY THE SOUTH METROPOLITAN GAS COMPANY FOR CONVERTING ALL THEIR SQUARE LANTERNS FOR LIGHTING THE BYE ROADS.

Fitted with "Talbot" Deflector and Chimney.

19, FARRINGDON ROAD, E.C.

JOHN BROWN & CO., LTD., SHEFFIELD,

Proprietors of

ALDWARKE MAIN, CAR HOUSE & ROTHERHAM MAIN COLLIERIES, NEAR ROTHERHAM.

ALDWARKE MAIN GAS COAL

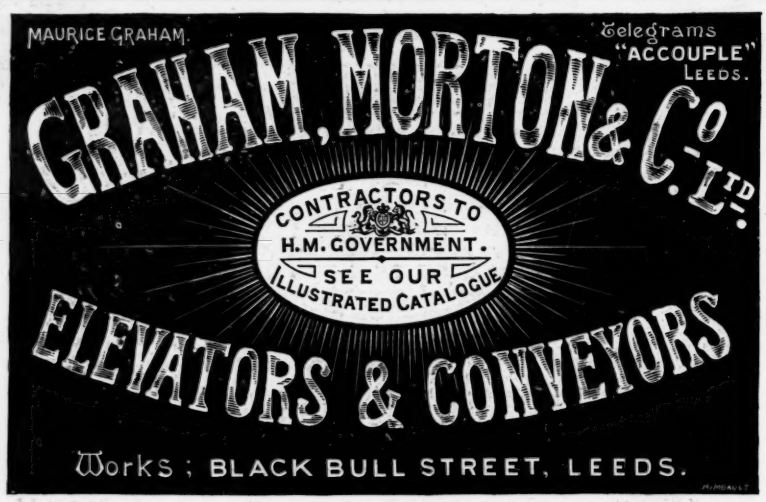
Analysis: 12,600 Feet of 19-Candle Gas per Ton.

Value in Pounds of Sperm, 820·80.

VERY FREE FROM IMPURITIES.

TELEGRAMS: "ATLAS, SHEFFIELD."

WE EXHIBIT AT THE PARIS EXHIBITION OUR INCLINED RETORT SYSTEM.



WE EXHIBIT AT THE PARIS EXHIBITION OUR INCLINED RETORT SYSTEM.

AMERICAN GAS OIL

SOLE IMPORTERS—

ANGLO-AMERICAN OIL COMPANY, LIMITED.

This well-known quality of Oil is used at most of the Corporation Works and Companies' Works throughout the United Kingdom. Contracts have also been entered into with several of the large Railway Companies.

LARGE STOCKS. PROMPT DELIVERY.

Stock of about 30,000 Tons is usually carried by us at our Installations at Avonmouth, Birkenhead, Barrow, Manchester, and London.

HEAD OFFICE:

22, BILLITER STREET, LONDON, E.C.

CLAYTON SON & Co. LTD

MAKERS OF

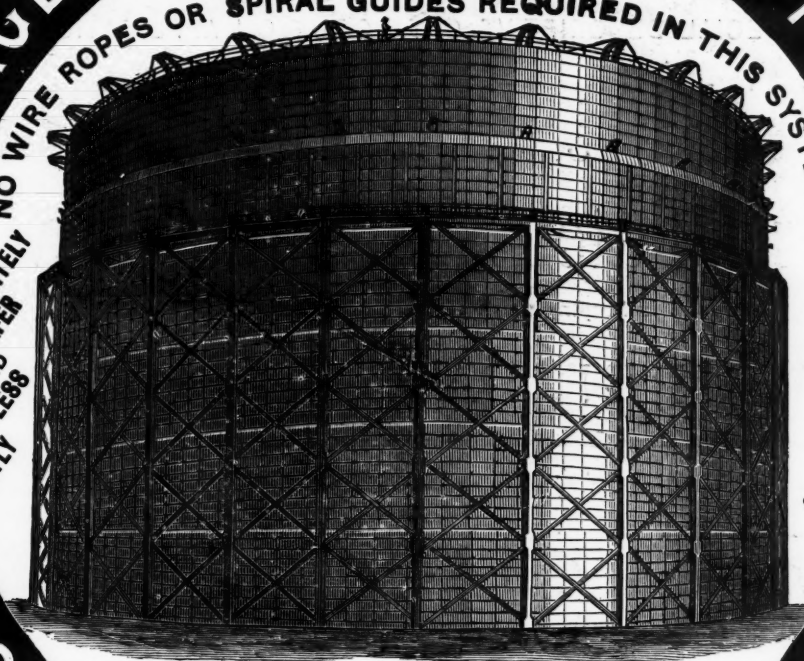
WORKS LEEDS

THE LARGEST GASHOLDER IN THE WORLD

GASHOLDERS OUR SPECIALITY

NO WIRE ROPES OR SPIRAL GUIDES REQUIRED IN THIS SYSTEM.

INFINITELY SAFER AND FAR LESS COSTLY THAN ROPES OR SPIRAL GUIDES.



CAPACITY 12 MILLION CUBIC FT.

ERECTED AT EAST GREENWICH FOR THE South Metropolitan Gas Company
IT HAS SIX LIFTS 30 FT DEEP EACH AND IS 300 FT DIAR

MAKERS OF GAS PLANT OF EVERY DESCRIPTION

ROOFS PURIFIERS &c. ALSO

ADDRESS LONDON 60, QUEEN VICTORIA ST.

TELEGRAPHIC "GAS, LEEDS.

GASHOLDERS OF ANY SIZE

ERECTED & COMPLETED WITHIN 12 MONTHS AND AT THE TIME SPECIFIED

MAKERS OF HIGH-CLASS

BOILERS.

S. CUTLER AND SONS, MILLWALL, LONDON.

GASHOLDERS

OF EVERY SIZE AND DESCRIPTION.

CUTLER'S PATENT GUIDE-FRAMING HAS BEEN ADOPTED FOR MANY IMPORTANT HOLDERS.

Carburetted Water-Gas Plant.

SPECIAL DESCRIPTIVE CATALOGUE ON APPLICATION.

PATENT WATER-TUBE CONDENSER

Over 120 now in use.

Cutler's Patent Freezing Preventer

For keeping Cups of Gasholders free from Ice.

CHARLES HUNT PATENT GAS-WASHER.

ESTABLISHED 1844. **ORIGINAL MAKERS.** ESTABLISHED 1844.

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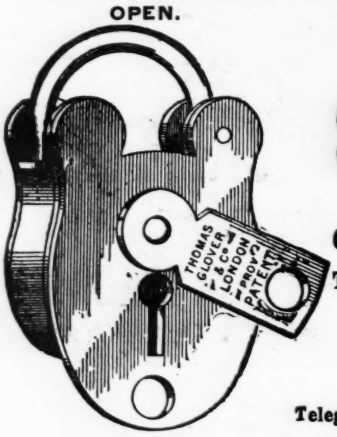

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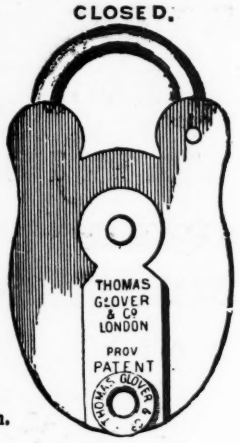

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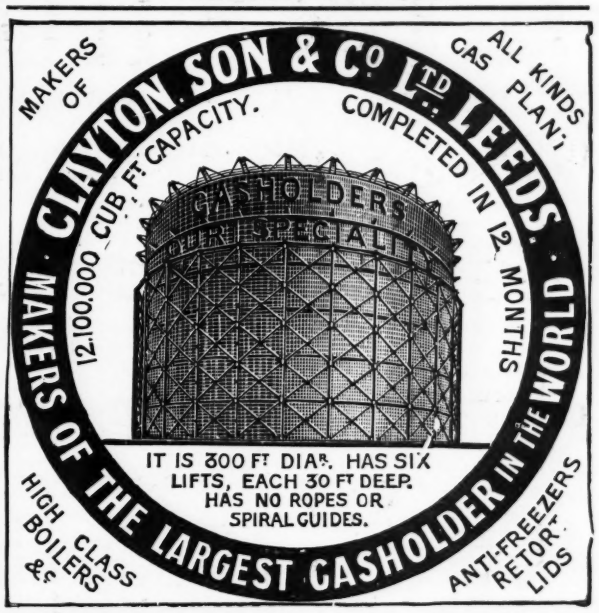
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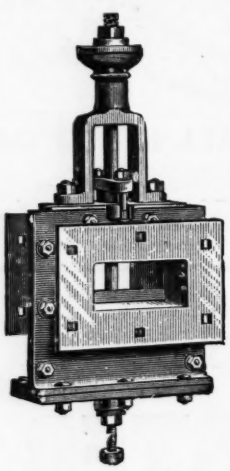

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